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DEVELOPMENT AND TEST OF NYLON ROTATING BAND  
FOR 20MM HIGH VELOCITY PROJECTILE

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DAHLGREN, VIRGINIA

*Rotating Band*

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U. S. Naval Proving Ground  
Dahlgren, Virginia

Development and Test of Nylon Rotating Band  
for 20mm High Velocity Projectile

by

R. B. Butler  
Terminal Ballistics Department

NPG REPORT NO. 1342  
NAVORD REPORT NO. 1339

Task Assignment No.  
NPG-B-3b-225-1-54

10 March 1955

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CONTENTS

	<u>Page</u>
Abstract . . . . .	ii
Foreword . . . . .	iii
Introduction . . . . .	1
Procedure and Results. . . . .	1
Discussion . . . . .	11
Conclusions. . . . .	13
References . . . . .	13
Appendices:	
A. NPG Photographs and Drawings (Figures 1-15)	
B. Recovery Data (Tables 1-3)	
C. Velocity and Pressure-Time Data (Table 4 and Figures 16-18)	
D. Accuracy Data (Tables 5-7)	
E. Data Pertaining to the Rapid-Fire Gun Life Tests	
F. Rapid-Fire Data - Chrome Plated Guns (Tables 8-27)	
G. Rapid-Fire Data - Unplated Guns (Tables 28-37)	
H. Distribution	

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NPG REPORT NO. 1342  
NAVORD REPORT NO. 1339

### ABSTRACT

Previously reported work on the development of a nylon rotating band for the 20mm aircraft gun Mk 12 had shown that the band as developed imparted full spin to the projectile, obturated satisfactorily, and did not fringe noticeably or produce unacceptable yaw, in slow fire at muzzle velocities up to 3500 ft/sec and at temperatures from -65° to 160°F. On the basis of a relatively small amount of firing, the band appeared to be completely retained in flight even at the temperature extremes. This report continues the account of the development work on this band, including additional extreme temperature firing, firing for ballistic accuracy, and rapid-fire tests.

The extreme temperature firing indicated that a band design and a method of molding have been achieved which produce a band that is retained in flight at all firing conditions.

The rapid fire results showed that very satisfactory performance of the band is obtained even in a very hot gun. In chromium-plated barrels the nylon bands produce a spectacular increase in gun life. One barrel has been fired for over 2400 rounds on a severe schedule with practically no wear, while a similar barrel fired on the same schedule with gilding-metal bands was worn out after 1000 rounds. Unplated barrels also show an increase in life with nylon bands, but not to a similar extent. No evidence of band loss in rapid fire has been observed. Yaw performance in rapid fire has been in some cases inferior to that observed with gilding-metal bands, but none of these cases having occurred at less than 150 rounds of burst firing, they are not considered to be of importance in service use. The short-range dispersion obtained in rapid fire is generally comparable with that obtained with gilding-metal bands.

In accuracy firing (slow fire in a Mann barrel) acceptable dispersion at long range is obtained.

A report bearing on the storage life of nylon bands is in preparation.

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NAVORD REPORT NO. 1339

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### FOREWORD

The work described in this report was conducted by authority of reference (a) under Task Assignment NPG-B-3b-225-1-54, during the period 1 February 1953 to 1 May 1954. This is the twentieth partial report submitted under this task assignment, "Projectile Rotating Bands and Components".

The nylon bands injection molded on the projectiles and fired in these tests were produced by Nylon Molded Products Corporation, Garrettsville, Ohio, (commercial molders) or by the Naval Ordnance Laboratory. The Naval Ordnance Laboratory molding was done under the technical supervision of S. Prosen of the Plastics Division. Chromium plating of Mk 11 gun barrels was accomplished at the National Bureau of Standards, under the technical supervision of J. Young.

The tests upon which this report is based were conducted by:

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## INTRODUCTION

Reference (b) reported the original design and development work on a nylon rotating band for the 20mm Mk 12 aircraft gun, as well as the results of the evaluation in slow fire of relatively small samples of band models for spin, obturation, fringing, yaw near the muzzle, degree of band retention in flight, and performance at extreme temperatures. It was found that the bands developed imparted full spin to the projectile, obturated satisfactorily, and did not fringe noticeably or produce unacceptable yaw, in slow fire from a Mk 12 gun at muzzle velocities up to 3500 ft/sec and at temperatures from -65° to 160°F. On the basis of a relatively small amount of firing, the bands appeared to be completely retained in flight even at the temperature extremes.

This report continues the account of the development work on this band, including more extreme temperature firing, accuracy firings, and rapid-fire tests.

## PROCEDURE AND RESULTS

### Recovery Firing to Determine Band Retention

The bands under evaluation in this phase were of two NOL lots, previous tests of which, as well as manufacturing details, were reported in reference (b). Briefly, the two lots were the same except that Lot 4A was molded at a mold temperature of 190°F and a projectile temperature of 160°F, while for Lot 4B the mold was at 60°F and the projectile at 75°F. Both lots were of OV3 long bands, molded on Type 2 Mod 2 projectiles, as shown in Figure 1, left.

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NPG REPORT NO. 1342  
NAVORD REPORT NO. 1339

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Projectiles from each lot were subjected to temperature conditioning as follows:

No. of Rounds

<u>Lot 4A</u>	<u>Lot 4B</u>	<u>Conditioning</u>
10	10	Dry at 160°F for 7 days, ambient for 24 hours, -65°F for 4 hours, fired at -65°F.
10	10	-65°F for 4 hours, +160°F (dry) for 4 hours, ambient for 16 hours, this cycle repeated 7 times. Projectiles brought to -65°F for 4 hours and fired.
7	10	160°F and 100% relative humidity for 7 days, fired at 160°F.

The projectiles were fired for recovery from a new Mk 11 Mod 2 barrel. Microflash photographs (Figure 2 shows typical examples) were taken of all rounds in flight at 100 feet from the muzzle and spin was determined for some of the rounds on each test. The results are shown in detail in Tables 1, 2, and 3 (Appendix B). Except for band retention in the case of the lot 4A projectiles fired at -65°F, both lots performed satisfactorily in every regard at both high and low temperature. Out of 20 projectiles from lot 4A fired at -65°F, six showed some band loss. Results of the initial test of these lots (reported in reference (b)) also indicated that lot 4A bands would not be uniformly retained when fired at -65°F. Counting both tests, a total of 83 rounds have been fired at high, low and ambient temperatures. At -65°F lot 4A showed incomplete band retention on 8 out of 25 projectiles fired. Eight projectiles at ambient and seven projectiles at +160°F showed no loss. On the other hand no loss for lot B was shown for 25 projectiles fired at -65°F, 8 at ambient and 10 at +160°F.

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NAVORD REPORT NO. 1339

Neither lot showed any detectable deterioration in performance after a week's temperature cycling, nor after a week's exposure to 160°F and 100% humidity, which produces a soft band by reason of temperature softening and softening by moisture absorption. It is interesting to observe, in view of the fears which have sometimes been expressed of rapid and excessive dimensional changes of FM 10001 nylon, either by thermal expansion or moisture absorption, that in a week's exposure to such extreme conditions these latter bands increased in diameter by about 0.004, which is not enough to cause any interference with the gun chamber.

In view of the better band retention of Lot 4B, all nylon-banded 20mm projectiles subsequently procured, except a few for mold temperature studies, have been molded under similar conditions of mold and projectile temperature.

#### Development of Special Crimp

An attempt was now made to fire a powder charge determination, preparatory to conducting standard rapid-fire tests to determine gun life and projectile performance with 0.3 long nylon bands. In the 15-round bursts, which are a part of the charge determination, and which were the first bursts fired with 20mm nylon-banded projectiles, numerous small pieces of nylon were observed to be emitted from the breech of the gun.

This caused alarm, and the phenomenon was investigated by making up 15-round belts of standard ammunition with all rounds live except the last, which had an inert powder charge and a nylon band. When the belt was burst-fired, the nylon-banded round came to rest in the chamber, after going through the normal loading cycle, and was extracted and examined. It was found that the nylon bands were chipping and losing pieces by reason of the forward motion of the case over the projectile upon impact of the belt mechanism on the base of the case. This forward motion is not a new phenomenon since it is commonly observed with

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NAVORD REPORT NO. 1339

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standard gilding-metal-banded rounds, but while the gilding-metal band is sufficiently strong to act as a stop for the case without damage to itself, the nylon band is not. One of the rounds loaded in the fashion described is shown after extraction in Figure 3, left. High-speed motion pictures of the loading process confirmed that the band damage was occurring in this manner.

It was thus necessary either to improve the strength of the crimp, or to provide a stop other than the band for the forward motion of the case. Several attempts to improve the crimp strength were made, involving a deeper crimping groove, a double groove, or a more favorably shaped groove, but none of these was fully successful. Crimping the case with its forward edge as far back of the band as practicable, so as to permit a maximum forward motion before the band was contacted, was also unsuccessful. The problem was finally solved by cutting a notch, between the standard crimping groove and the after edge of the band, to hold the mouth of the case and prevent its touching the band. The mouth of the case is forced into this notch by a special jig during the operation of assembling projectile and case. The round is then rubber-crimped in the standard manner. This procedure, as compared with the standard assembly, involves no additional trouble or expense other than the cost of the special jig, and has been in use on all nylon-banded rounds fired subsequent to its development, with only a few exceptions when slow fire tests were conducted. Figure 4 shows the contour of the notch, and Figure 3, right, shows a round with the modified crimping groove after loading and extraction.

The deformation of the case mouth into the notch has caused no appreciable case damage on firing in slow fire or in bursts.

#### Abandonment of the O#2 Band

About the same time, burst firing in a standard-twist unplated barrel was attempted with bands O#2 long, earlier work on which has been described in reference (b). Some doubts had previously been felt about the adequacy of this design, which were justified when on the burst firing the

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NAVORD REPORT NO. 1339

majority failed badly to impart the required spin. In view of this result, the 0.42 band was abandoned, and no further work on it attempted. All projectiles fired subsequently have been of the Type 2 Mod 2 design, with bands 0.43 long and 0.828 in diameter (Figure 5), with the exception of some projectiles, as described later, with variations in diameter.

#### Determination of Pressure-Time Data

Pressure time data were obtained for nylon- and gilding-metal-banded projectiles fired from a Mann barrel fitted with a piezoelectric pressure gauge. Two different nylon bands were employed in this work, both 0.43 long, one 0.828 and the other 0.834 in diameter. The detailed results are given in Appendix C.

In brief, the results indicated little difference among the three types of projectile, except for a tendency for the nylon-banded projectiles to give a peak pressure one to two tons lower for about the same muzzle velocity and muzzle pressure. This is in line with what has been observed for nylon bands in other calibers, and is attributed to the lower engraving force and diminished bore friction characteristic of nylon.

#### Accuracy Tests

Three accuracy tests were fired from Mann barrels to determine the performance of the nylon-banded projectiles. In the first of these, six ten-round groups were fired at a vertical target 600' from the gun. One group consisted of reference rounds (standard gilding-metal-banded Mk 11 Mod 0 projectiles); one of Type 2 Mod 2 projectiles; one of Type 2 Mod 2 projectiles crimped in the case with the same crimp as the standard gilding-metal-banded projectiles, that is, without the additional crimping notch used with the other nylon-banded projectiles; one of Type 2 Mod 2 projectiles at -65°F; and one each of Type 2 projectiles at band diameters of 0.823 and 0.834. The projectiles with 0.834 bands were not crimped at all, since it was discovered too late that they could not be crimped without modifying the equipment.

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NAVORD REPORT NO. 1339

In the second test, 25 or 26-round groups were fired at 1500 yards range, comparing standard projectiles, Type 2 Mod 2 projectiles, and Type 2 projectiles with band diameter of 0.834 and 0.836 diameters.

In the third test, ten-round groups were fired at 600' range, comparing reference projectiles, Type 2 Mod 2 projectiles, and Type 2 Mod 6 projectiles, the latter being identical to the Type 2 Mod 2 projectiles except for the provision of an after bourrelet behind the band of 0.784 diameter (an increase in diameter of 0.014).

The detailed results are given in Appendix D, and are summarized in the following table, which gives for each group the horizontal and vertical standard deviations in mils, and the RMS average of these two quantities. If horizontal and vertical dispersions are equal, the RMS average gives the best estimate of a figure of merit for the accuracy of the round.

Standard Deviations (Mils) of Points of Impact of  
Nylon-banded 20mm Mk 11-O Projectiles Fired from Accuracy Barrels

<u>Projectile Type</u>	<u>Horizontal</u>	<u>Vertical</u>	<u>RMS Average</u>
------------------------	-------------------	-----------------	--------------------

Test of 10-round groups at 600' range on 7 August 1953

Standard	0.40	0.20	0.31
T2-2	0.50	0.79	0.66
T2-2 (Service Crimp)	0.87	0.74	0.80
T2-2 (at -65°F)	0.52	0.35	0.44
T2 at 0.823 diameter	0.54	0.44	0.49
T2 at 0.834 diameter (Not crimped)	0.36	0.53	0.46

Test of 25-26-round groups at 1500 yd. range on 22-26 August 1953

Standard	0.41	0.40	0.40
T2-2	0.62	0.90	0.77
T2 at 0.834 diameter	0.57	0.63	0.60
T2 at 0.836 diameter	0.60	0.67	0.64

Test of 10-round groups at 600' range on 11 March 1954

Standard	0.34	0.21	0.28
T2-2	0.36	0.45	0.41
T2-6	0.77	0.66	0.72

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NAVORD REPORT NO. 1339

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These results show a general increase in standard deviation for nylon over gilding metal. For the Type 2 Mod 2 projectile this increase is by a factor of 1.5 to 2. Firing the nylon band cold (-65°F) or at large or small diameter appears to improve the accuracy somewhat, although it does not bring it up to the level of the gilding metal band. There was initially considerable doubt whether the greater dispersion with nylon was to be attributed to a less firm centering of the projectile in the gun, particularly at exit, or to a small amount of fringing. The diminished dispersion with cold bands and with bands of altered diameters could support either hypothesis. In an effort to distinguish, the Type 2 Mod 6 projectiles were made up and fired in the third test. That this projectile, with a larger body diameter aft of the band, showed greater dispersion is considered to support the idea that there is some degree of fringing which causes the increased dispersion.

The actual amount of dispersion for the nylon-banded projectile is not great, and it is considered that in service the increase over the metal-banded projectile would be completely masked by dispersion attributable to the gun, the fire control system, and the aircraft.

#### Rapid-Fire Tests

The standard firing cycle for rapid-fire barrel life tests with the 20mm Mk 12 gun consists of twelve 50-round bursts (fired at a rate of about 1000 rounds per minute), with two minutes between bursts, and with complete cooling following the end of the cycle (600 rounds). In some cases, cold erosion checks are also fired. The criteria for end of life of the barrel, arrived at from experience with gilding-metal bands, are a 200 ft/sec loss in velocity averaged over a 50-round burst, or occurrence of yaw greater than 15° on 20% or more of the rounds in a burst, whichever occurs first.

In the rapid-fire tests, velocity, yaw, and dispersion are measured, and star-gauging of the barrel is conducted. Details of these measurements, as well as data on the ammunition components and assembly, will be found in Appendix E.

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NAVORD REPORT NO. 1339

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Retention of nylon bands in rapid-fire was judged either by a thorough search of the ground in front of the gun for band fragments, or by firing through a wire-screen enclosure 30" x 30" x 48' long and checking for the presence of band fragments after each burst. No nylon band fragments were found in any test.

All nylon bands used in the rapid-fire tests were molded by Nylon Molded Products Corporation, and while all were molded under the same conditions so far as these could be controlled, the projectiles will be identified by lot numbers. A lot is defined as a set of projectiles whose bands have been molded in one mold, on one machine, and in the same run.

The barrels employed were either standard Mk 11 Mod 2 barrels (unplated), or Mk 11 Mod 2 barrels modified at the Bureau of Standards by electropolishing and plating chamber and bore with 0.006 of hard chromium.

The detailed data obtained in all the rapid-fire tests are contained in Appendices F (plated barrels) and G (unplated barrels). For convenience, the velocity data and barrel erosion results are summarized graphically in Figures 6 to 11, Appendix A, and the yaw and dispersion data are summarized in the table on the following page.

The first barrel tested with nylon bands was No. EX-184, a plated barrel. On the first two erosion cycles in this barrel, although gun wear was negligible, velocity maintenance excellent, and dispersion acceptable, a large number of yawed rounds were encountered.

With nylon bands, the first round in each burst in a well-heated gun, being charged into the chamber and remaining there for ten or fifteen seconds before firing, usually shows a large yaw. This is to be attributed to band failure as a result of heating the band, and it is not considered entirely fair to count this round in applying the yaw criterion stated above. The effect is of little service importance, since it does not occur until 150-200 rounds have been fired.

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SUMMARY OF YAW AND DISPERSION DATA

Barrel No.	Erosion Cycle	Band	Percentage of Rounds with Yaw in the Range				Measured Rds. in Cycle	Average Pattern Size for 50-round Burst (91' Muzzle Distance)		
			0-5°	6-10°	Over 15°			Horiz.	Vert.	
					11-15°	15°				
<u>Plated Barrels</u>										
EX-184	1	Nylon Lot S2A	40.6	16.2	18.2	24.9	598	22.4	23.6	
	2	Nylon Lot S2B	43.5	18.0	21.1	17.4	596	20.8	20.7	
	3	Nylon Lot S9	80.8	13.5	4.7	1.0	598	17.4	17.5	
	4	Nylon Lot S10, S10M, S9	93.6	2.9	2.1	1.3	595	19.4	18.0	
855108	1	Nylon Lot S10M	77.0	10.5	8.6	3.8	572	17.9	16.7	
854254	1	Nylon Lot S9	86.1	9.7	3.0	1.2	402	15.2	14.4	
EX-183	1	Gilding Metal	56.2	32.2	10.9	.7	681	16.7	16.2	
	2	Gilding Metal	57.8	26.9	12.8	2.5	483	14.4	15.5	
EX-182	1	Gilding Metal	40.6	24.5	31.9	3.0	470	15.3	15.2	
	2	Gilding Metal	47.8	25.5	17.6	9.1	427	13.4	14.2	
<u>Unplated Barrels</u>										
854342	1	Nylon Lot S2B	75.1	14.1	6.1	4.7	594	17.1	16.8	
	2	Nylon Lot S9	67.0	9.5	9.5	14.0	399	16.6	14.9	
856686	1	Gilding Metal	46.9	34.1	15.3	3.7	510	15.3	14.1	
855119	1	Gilding Metal	76.2	15.7	7.2	.8	235	Not Taken		

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Omitting from the count the first round of each burst after the third, one finds that the bursts in the first cycle which failed the yaw criterion were the third through the eighth, and the tenth. In the second cycle, the fifth, sixth, tenth, eleventh, and twelfth bursts failed the yaw criterion. The failure to pass the conventional yaw criterion was not taken very seriously, since there appeared to be no very definite trend toward deterioration of performance, successive bursts in the same cycle passing or failing in quite an arbitrary way. (This is not the case for barrels fired with gilding-metal bands, where shortly after the first burst to fail on yaw, the accuracy of the gun declines precipitously.) Furthermore, the negligible amount of wear of the gun indicated no reason to believe that the barrel performance should be deteriorating.

It was accordingly decided to continue testing this barrel, and two more cycles were fired. As shown in Figures 6 and 9, in the summary table above, and in Appendix F, the results of these two cycles were completely satisfactory. After 2464 rounds, the barrel showed practically no wear, the velocity drop was negligible, and the yaw performance was somewhat better than expected with gilding-metal bands.

In the fourth cycle of this barrel, the bands fired in the first, fourth, and eighth bursts were of a diameter reduced to 0.823. This experiment was made for two reasons: (1) work in other gun calibers had indicated a possible improvement in range accuracy by reduction of band diameter, and (2) investigations of artificial aging of nylon had disclosed the possibility that under prolonged storage under very humid and hot conditions, nylon bands at 0.828 diameter might increase in size just enough to be troublesome in seating in the chamber of the gun. The 0.823 diameter bands showed no detectable difference in performance.

One more plated barrel has been fired for one cycle with 0.828 nylon bands, and a third has been fired for one cycle with 0.823 nylon bands. Both, as the data in Figures 7 and 10, in the summary table, and in Appendix F show, gave excellent performance, similar to that shown in the third and fourth cycles of the first barrel. Two plated

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barrels have been fired to end of life with standard gilding-metal bands, for comparison. Both had a velocity life (to 200 ft/sec drop) of about 1000 rounds, and an accuracy life of about 1150 rounds (see Appendix F).

One unplated barrel has been fired to end of life with 0.828 diameter nylon bands, and two for comparison with standard gilding-metal bands. The results are given in detail in Appendix G, and are summarized as regards yaw and dispersion in the summary table above, and as regards velocity and barrel wear in Figures 8 and 11.

The unplated barrel with nylon bands began with excellent yaw performance, which declined suddenly on the last burst of the first cycle to an extent sufficient to fail the burst by the yaw criterion. This performance was checked by firing a second cycle, during which there was a rather similar decline at the eighth burst. The accuracy life of this barrel is therefore conservatively set at 550 rounds. The two comparison barrels indicated an end of velocity life at about 550 rounds, with the accuracy still acceptable.

Bore photographs of plated and unplated barrels having fired nylon or gilding-metal bands are shown in Figures 12 to 15, Appendix A. It is interesting to note in Figure 13, the photograph of the unplated barrel fired with nylon bands, the rather large wear of the driving edge producing a tapered top of the land. This type of wear does not produce very much effect on the star-gauge readings, but may well be expected to promote failure of the nylon band. The photograph of the plated barrel fired with nylon bands shows no such effect.

### DISCUSSION

It is gratifying that the problem of obtaining acceptable performance of nylon bands in a very hot gun presented no more difficulty than it did. Apparently the poor heat conductivity of the nylon, and the short time it remains in the barrel, prevent any appreciable heat softening of the material except in the case of the first round in a burst, as mentioned above.

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The phenomenal increase in life observed with nylon bands in plated barrels is in line with results in other calibers. As a general rule, in plated guns the chromium prolongs the life of the gun essentially by the number of rounds it manages to stay intact. After the plating is breached, which occurs in the region of the origin, the gun wears at the same rate as an unplated gun. A nylon band, being considerably softer than a metal band, inflicts much less damage on the chromium in the process of engraving, and the chromium thus lasts for a number of rounds at present indeterminately large.

The reasons for the occurrence of numerous yawed rounds in two rapid-fire cycles with nylon bands, and their absence in four other cycles, is not understood at present, and must be investigated further. There appears to be some chance that this phenomenon is connected with the action of the gun and feeder, and that nylon is more sensitive to variations in such action than is gilding metal. Variations in ballistic conditions or in quality of nylon do not seem capable of yielding an explanation. At any rate, since the phenomenon does not occur in the first 100 or 150 rounds fired in a cycle, it may be of little consequence in service.

That the increased long-range dispersion observed with nylon bands in slow fire in a Mann barrel is not of serious consequence is supported by a comparison of the short-range dispersion patterns in rapid-fire given by nylon and gilding-metal bands, which are considerably closer together.

A comparison of the pattern sizes shown by the two band materials, from the summary table, indicates no appreciable difference, except for the two cycles which had the numerous yawed rounds. Inspection of the detailed tables in the Appendices shows that even for these two cycles the pattern sizes for the first two or three bursts are close to those characteristic of gilding metal.

A report is in preparation dealing with accelerating aging tests, which bear on the problem of storage life of nylon bands, with some data on the effect of molding conditions on the quality of nylon.

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### CONCLUSIONS

The extreme temperature firing indicated that a band design and a method of molding have been achieved which produce a band that is retained in flight at all firing conditions.

The rapid-fire results showed that very satisfactory performance of the band is obtained even in a very hot gun. In chromium-plated barrels the nylon bands produce a spectacular increase in gun life. One barrel has been fired for over 2400 rounds on a severe schedule with practically no wear while a similar barrel fired on the same schedule with gilding-metal bands is worn out after 1000 rounds. Unplated barrels also show an increase in life with nylon bands, but not to a similar extent. No evidence of band loss in rapid-fire has been observed. Yaw performance in rapid-fire has been in some cases inferior to that observed with gilding-metal bands, but none of these cases having occurred at less than 150 rounds of burst firing, they are not considered to be of importance in service use. The short-range dispersion obtained in rapid-fire is generally comparable with that obtained with gilding-metal bands.

In accuracy firing (slow fire in a Mann barrel) acceptable dispersion at long range is obtained.

### REFERENCES

- (a) BUORD Conf ltr NP9 Re3b:CFJ:mt Ser 63652 of 24 September 1953
- (b) NPG Conf Report No. 1099 of 28 February 1953
- (c) NPG Conf Report No. 845 of 3 September 1951



APPENDIX A

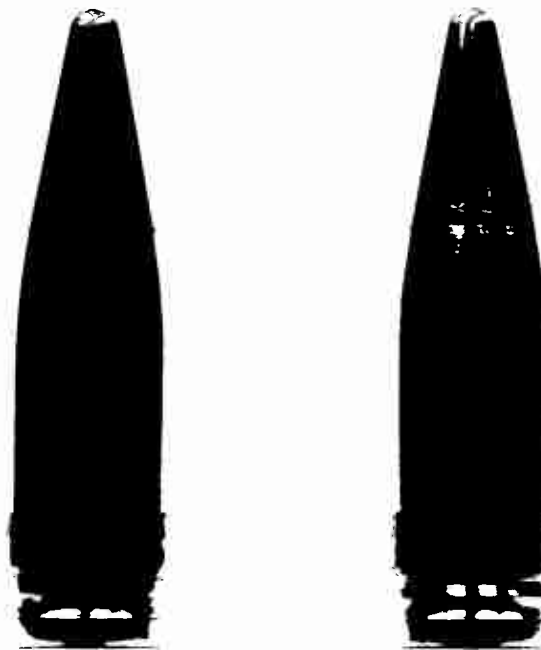


Figure 1

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Typical 20mm Type 2 Mod 2 projectiles before firing. View on right has modified crimping groove.

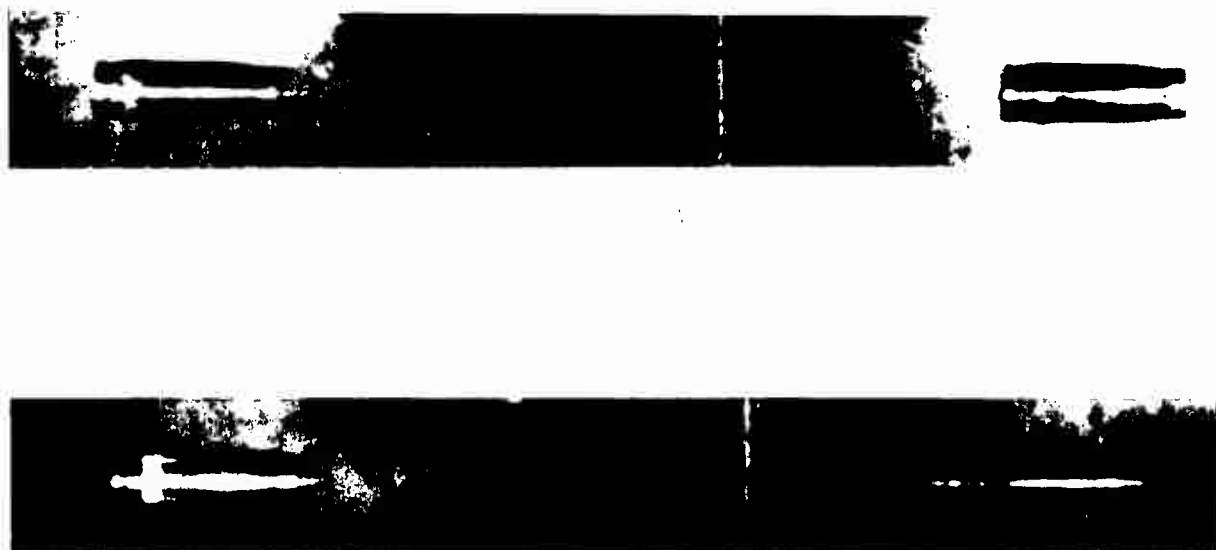
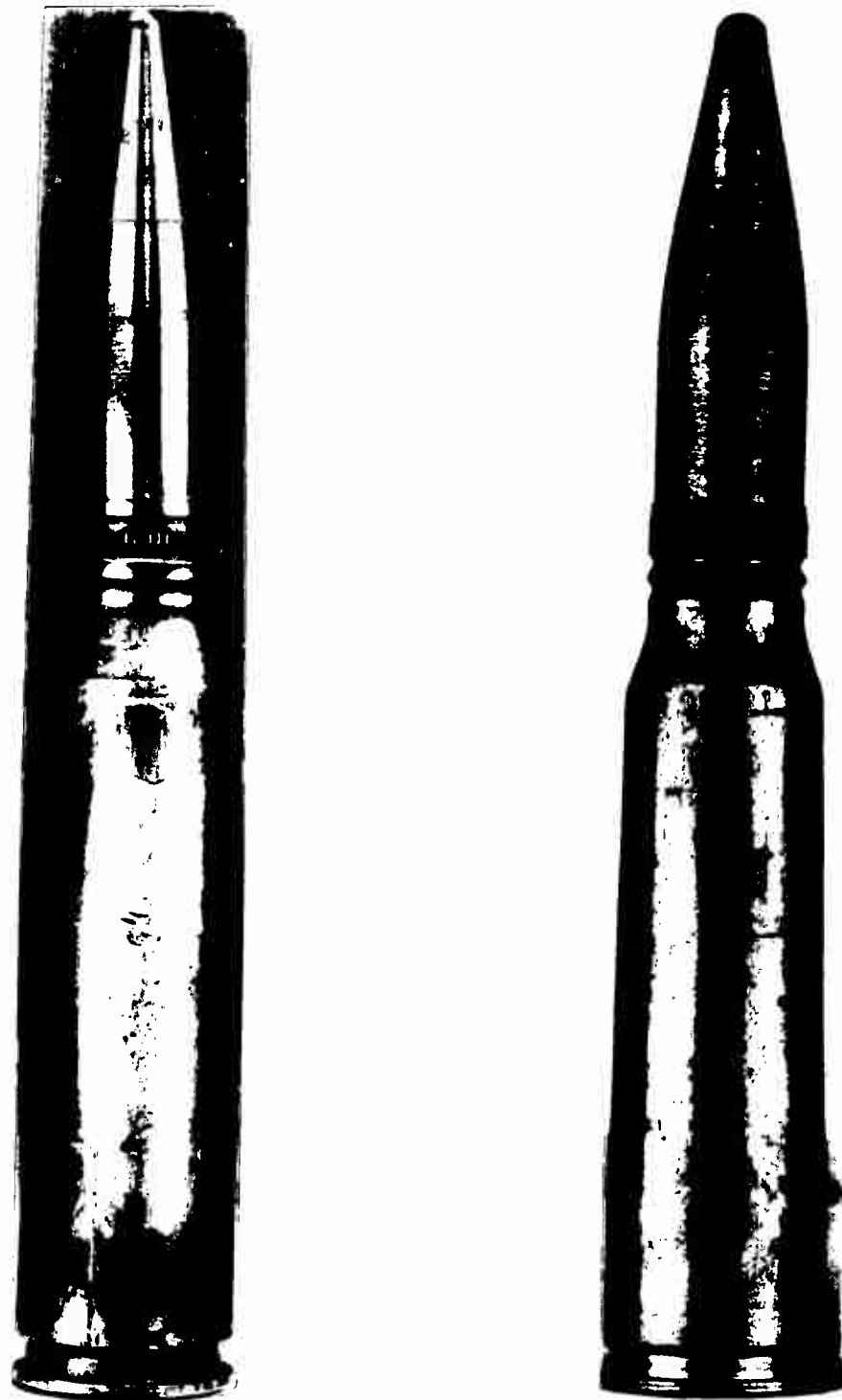


Figure 2

NP9-67010  
~~CONFIDENTIAL~~

Microflash photographs, 100 ft. from muzzle, of 20 mm projectiles. Top view shows band retained and lower view illustrates typical band loss if loss did occur.



**Figure 3**

NP9-67012

~~CONFIDENTIAL~~

20mm Type 2 Mod 2 Projectile assemblies after  
subjection to normal loading cycle showing  
ramming effect on standard crimp (left) and  
on modified crimp (right).

NP9 67026

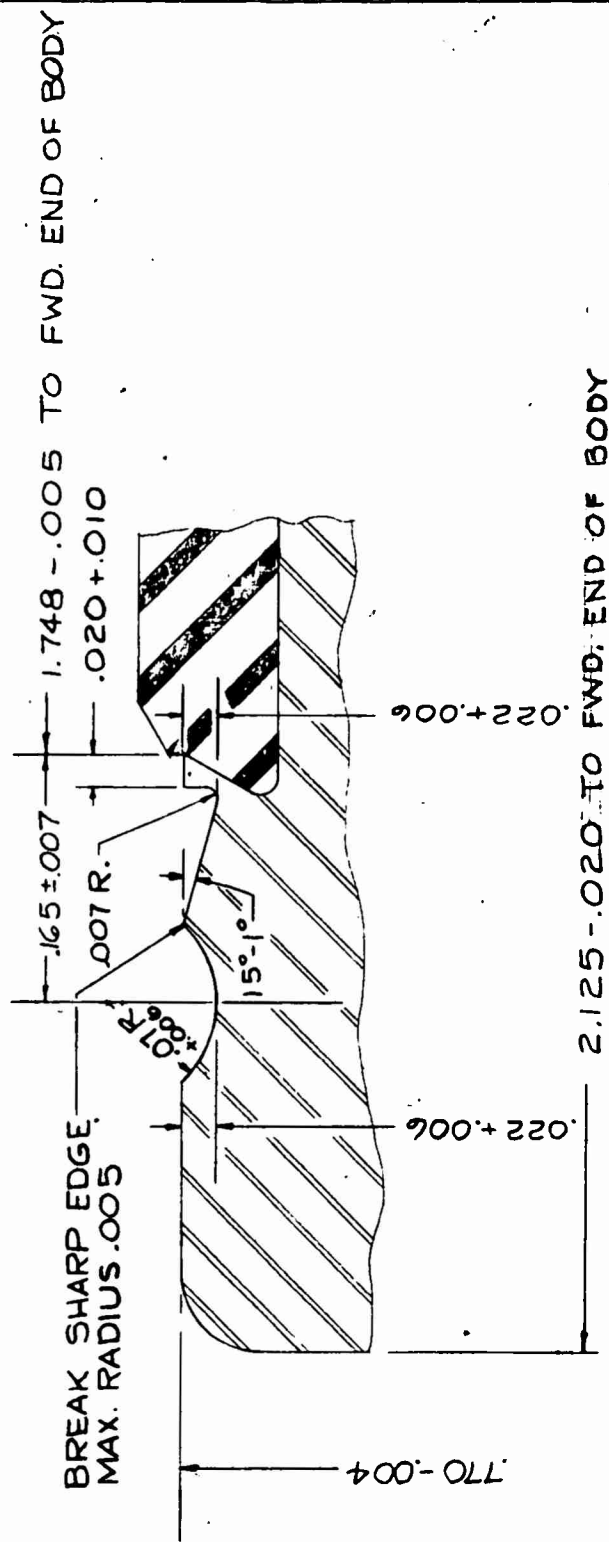
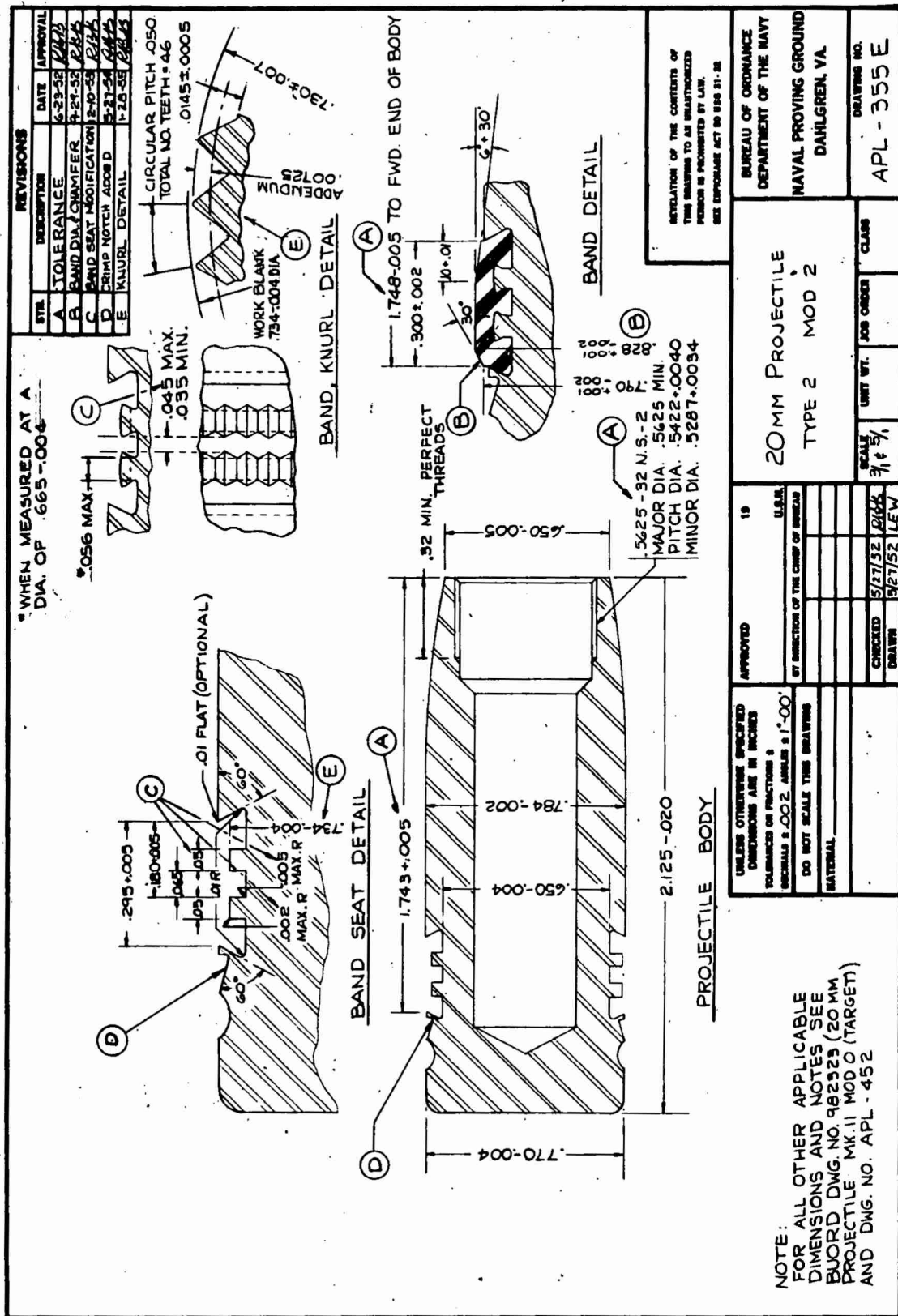


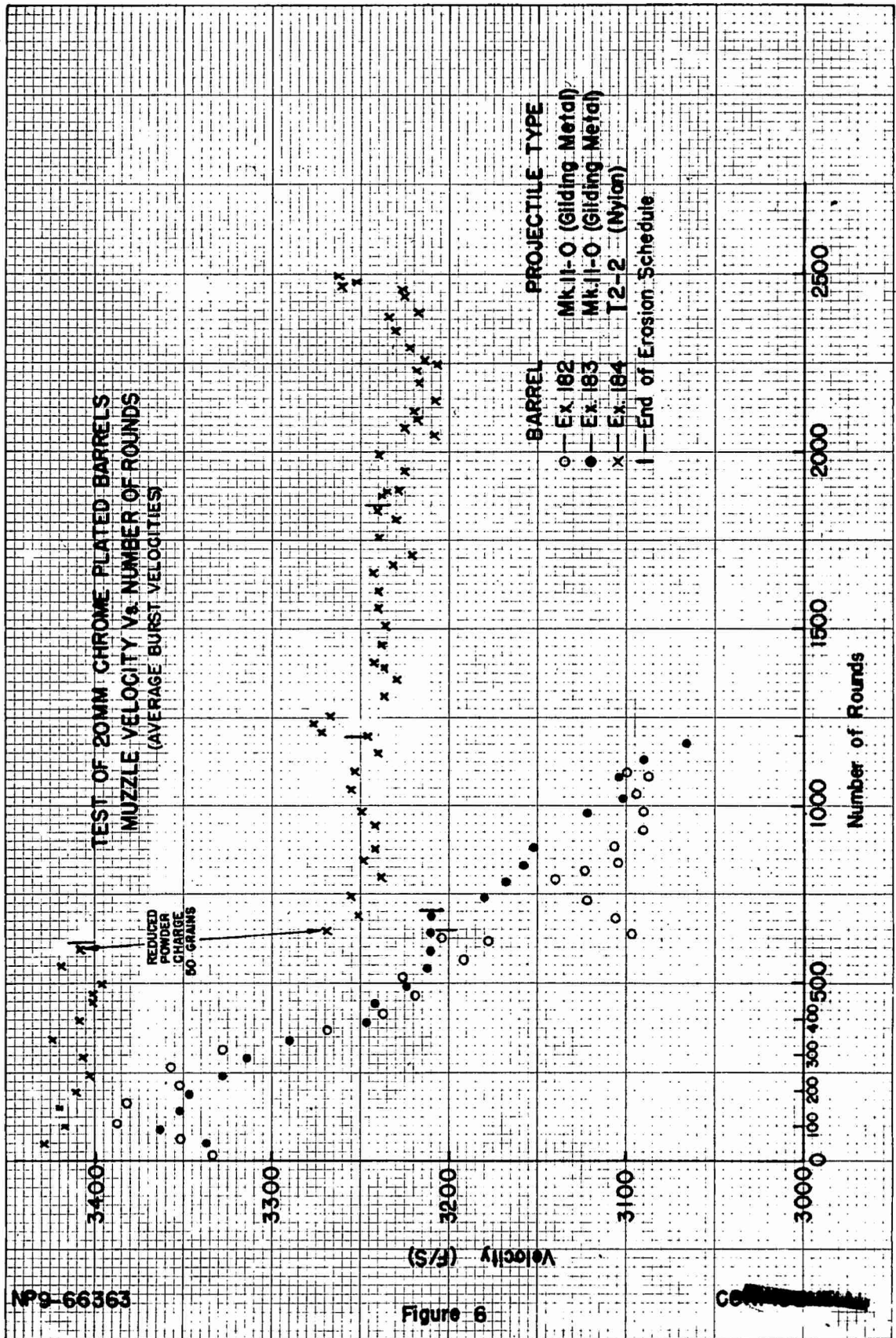
FIGURE 4

MODIFIED CRIMPING GROOVE  
FOR 20MM PROJECTILE TYPE 2 Mod 2

SCALE: 10-1  
4/20/53 LEW

DRAWING NO.  
APL -452





NP9-66363

Figure 6

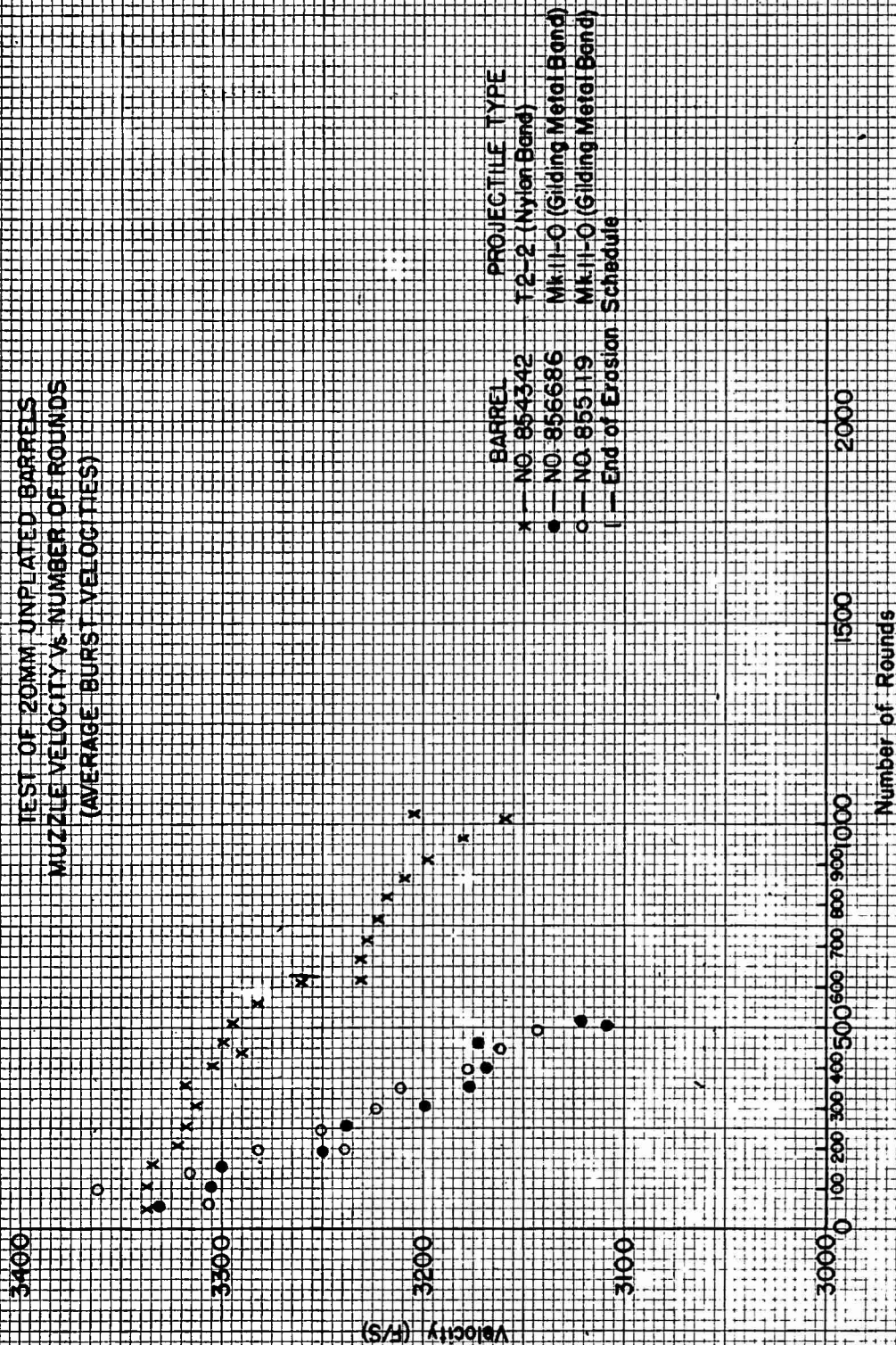
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TEST OF 20MM CHROME PLATED BARRELS  
MUZZLE VELOCITY VS NUMBER OF ROUNDS  
(AVERAGE BURST VELOCITIES)





TEST OF 20MM UNPLATED BARRELS  
MUZZLE VELOCITY VS. NUMBER OF ROUNDS  
(AVERAGE BURST VELOCITIES)



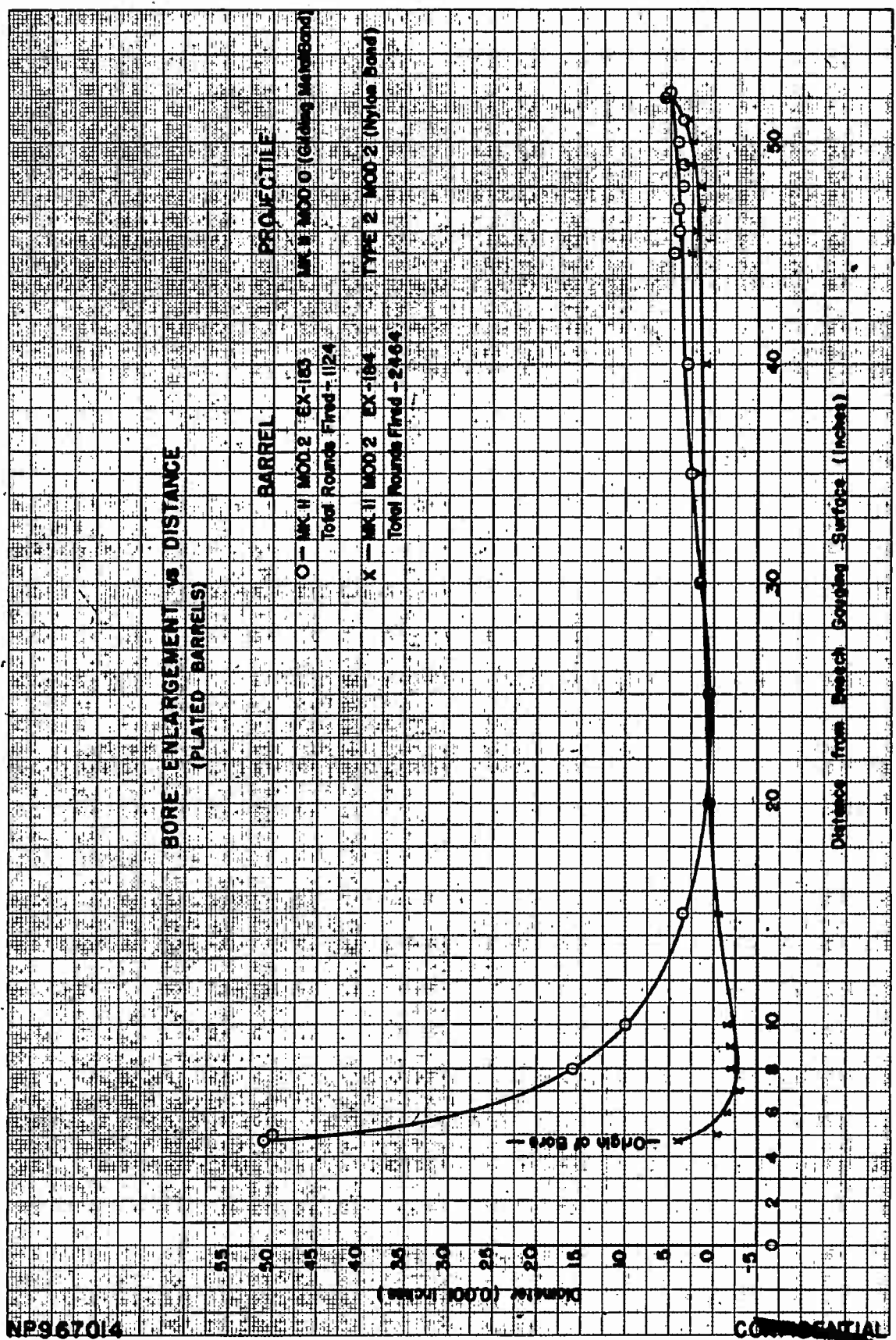
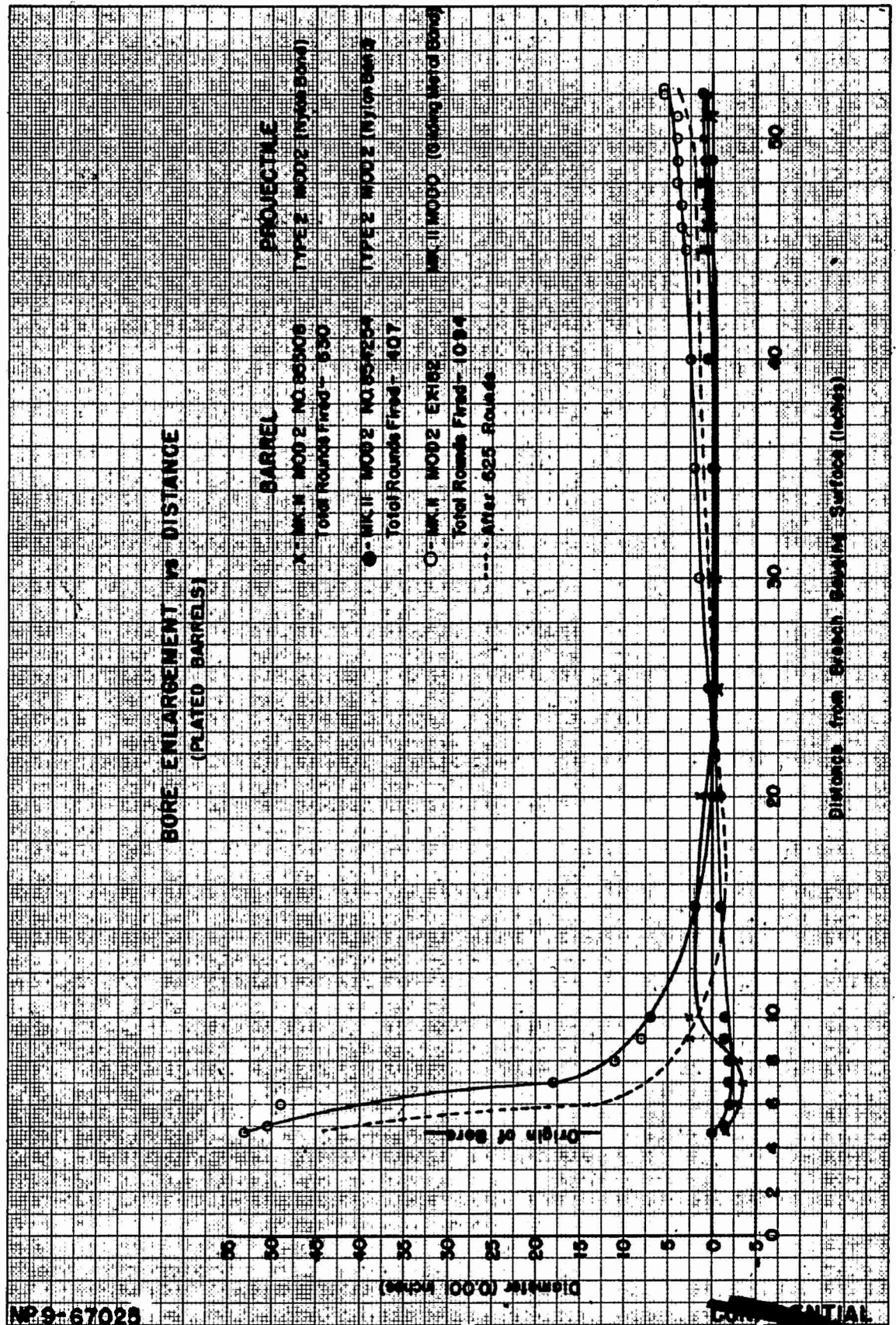


Figure 9



NP 9-67028

Figure 10

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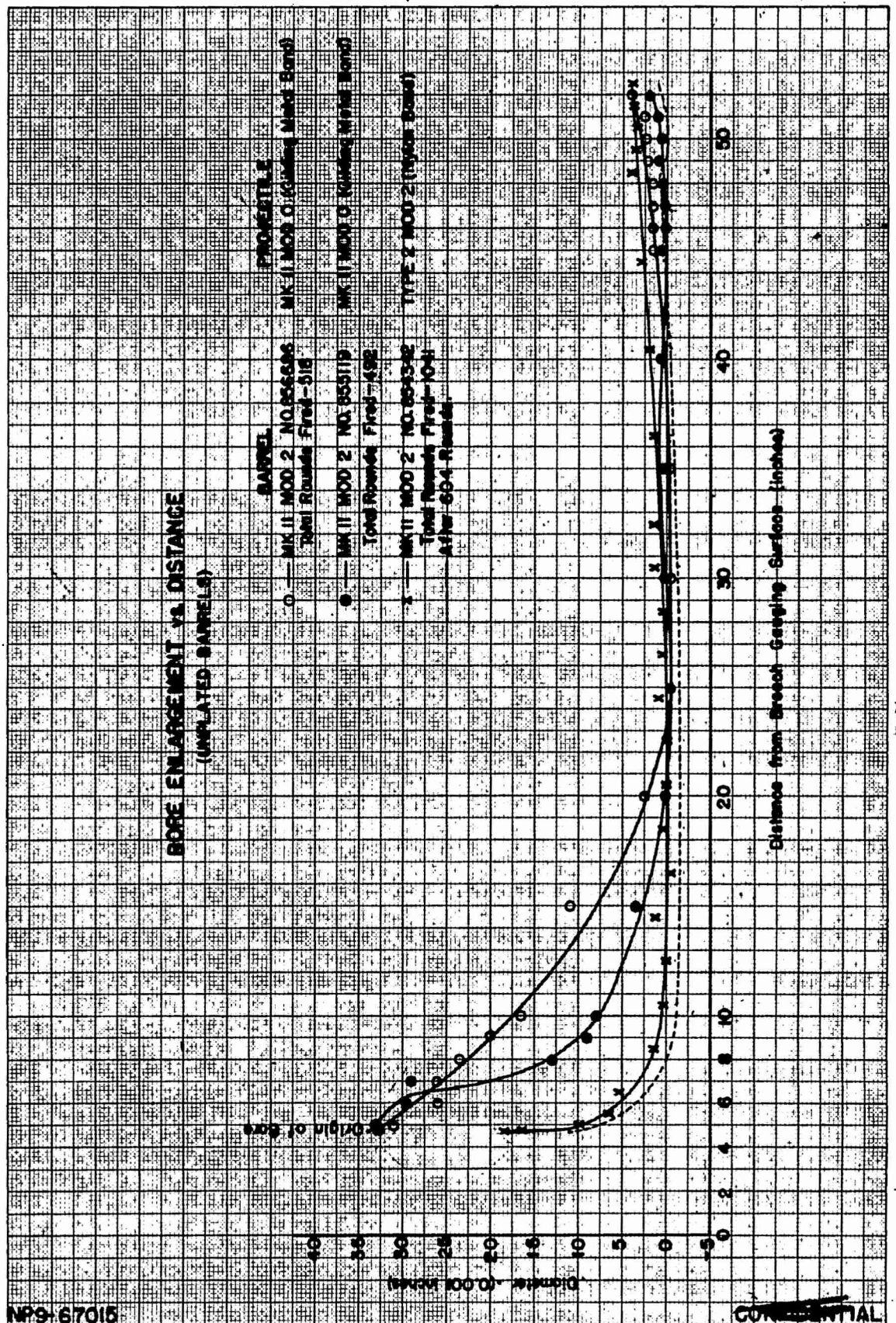
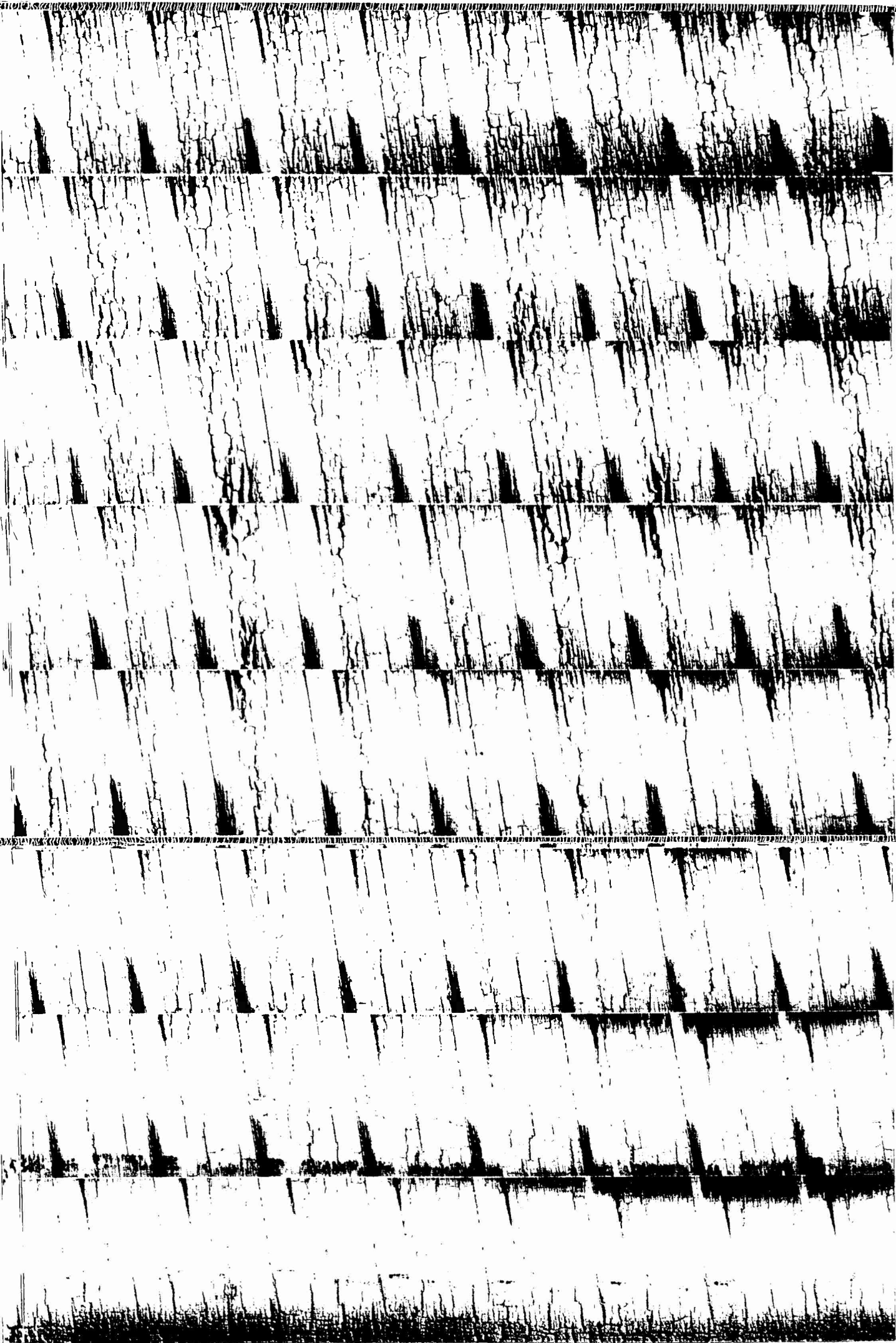


Figure 11







Distance from Breech

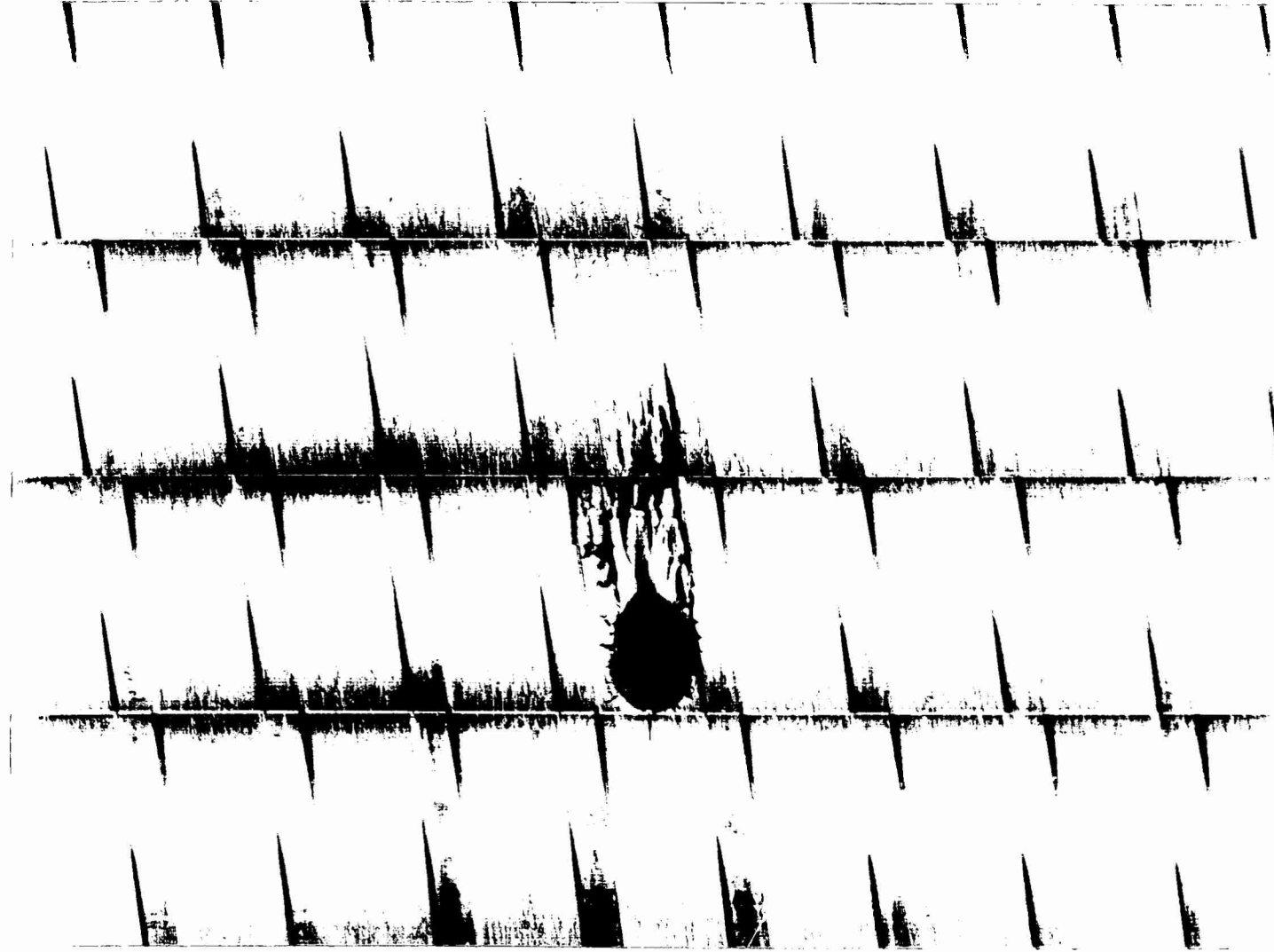
4'7"  
Origin  
of Bore

5'0"

6'0"

7'0"

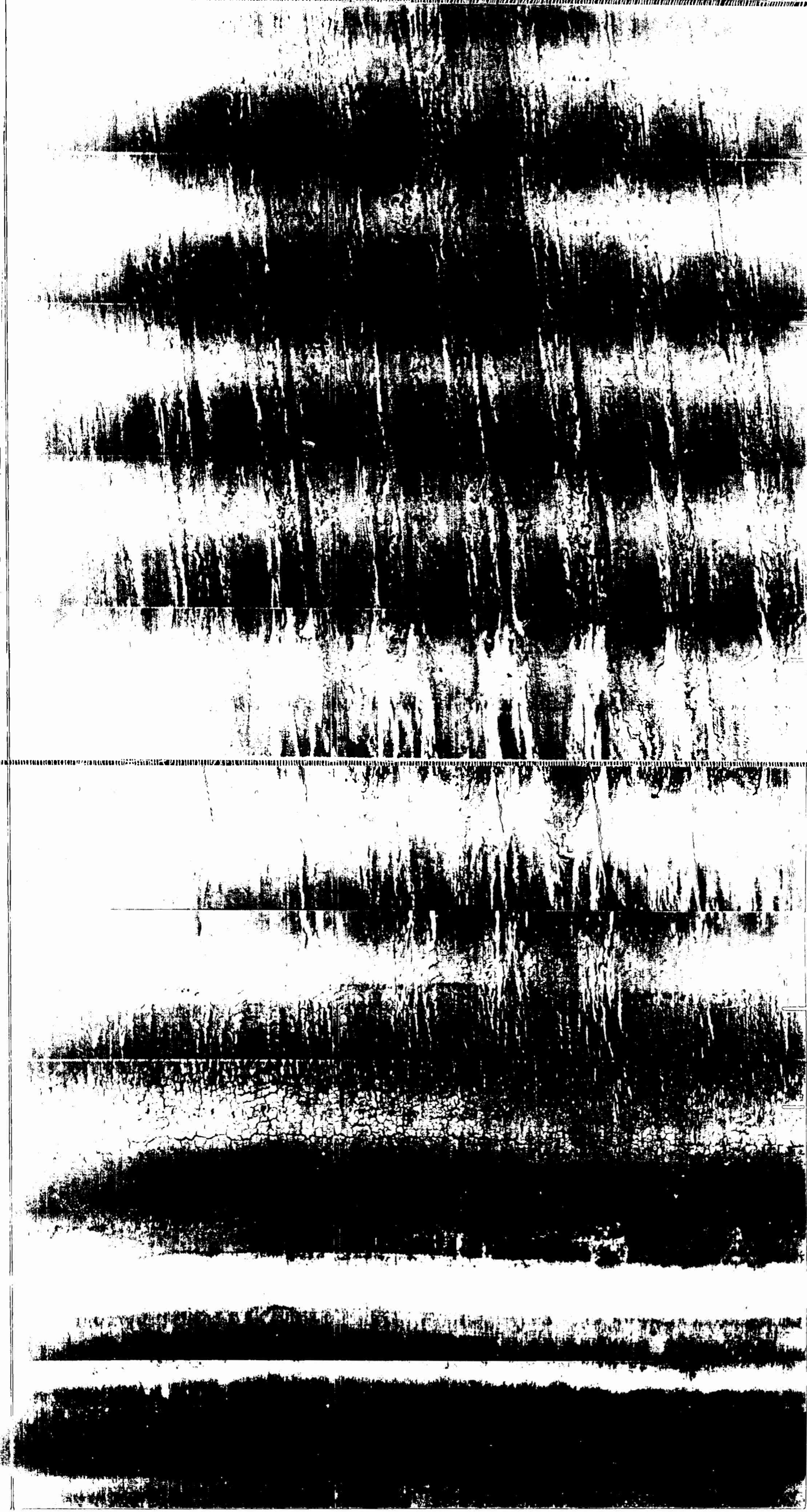
7'5"



23'9"  
Gas Port

Figure 13

NP9-67029 ~~CONFIDENTIAL~~ Bore Photograph of Unplated 20mm  
Gun Barrel No. 854342 after firing  
1041 rounds of Type 2 Mod 2 (nylon  
banded) projectiles.



Distance from Breech

4.7  
Origin  
of Bore

6.0

7.0

7.5

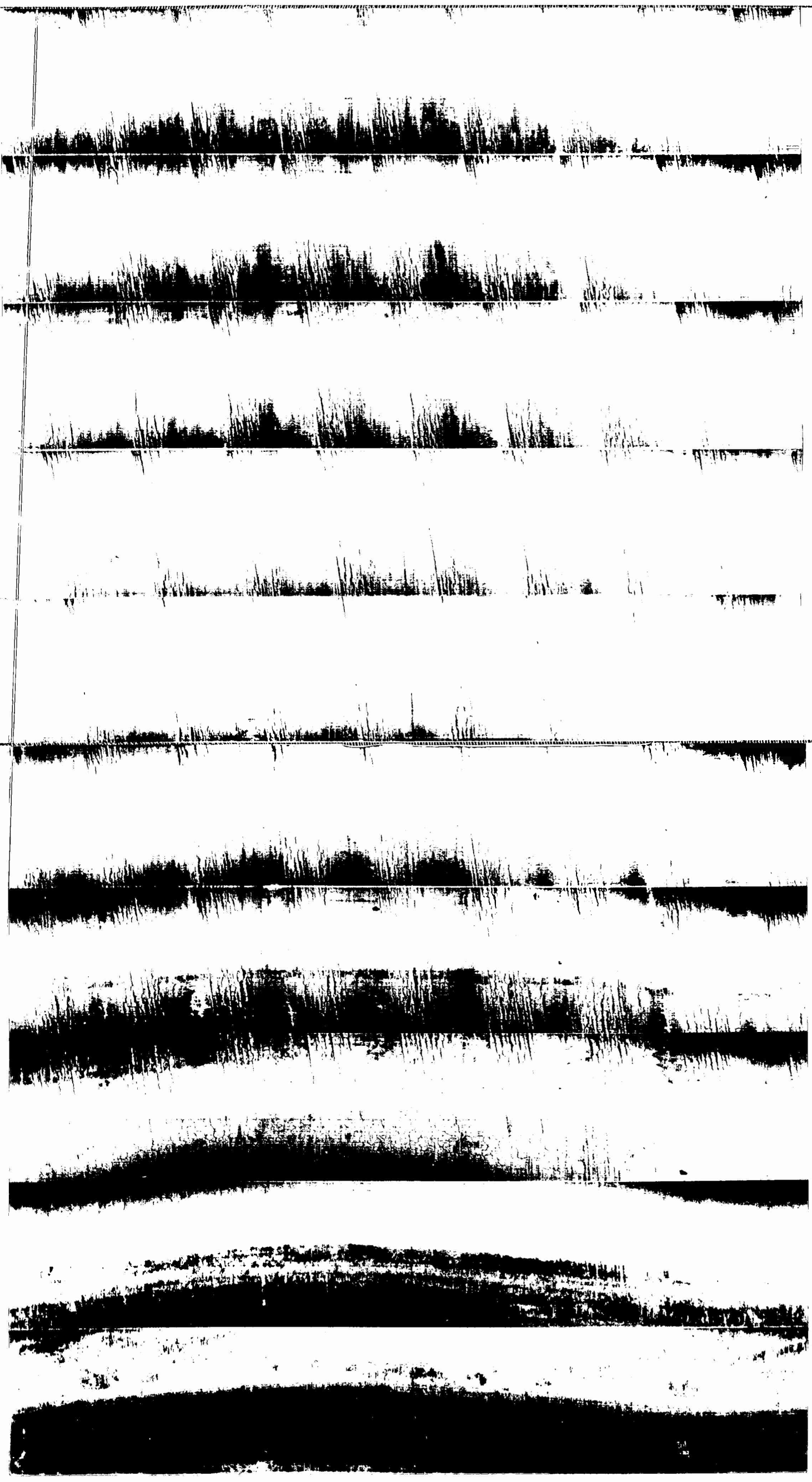
23.9  
Gas Port

Figure 14

NP9-67028  
CONFIDENTIAL

Bore Photograph of Chrome Plated 20mm  
Gun Barrel No. FX 183 after firing  
1177 rounds of Mk II Mod O (gilding  
metal bands) projectiles.





Distance from Breech

4"7  
Origin  
of Bore

6"0

7"0

7"5

23"9  
Gas Port

Figure 15

NP9-67030  
CONFIDENTIAL

Bore Photograph of Unplated 20mm Gun  
Barrel No. 856686 after firing 518 rounds  
of Mk 11 Mod 0 (gilding metal bands)  
projectiles.



APPENDIX B

TABLE 1

## COMPLETE BEFORE AND AFTER FIRING DATA

Recovery Test of 20mm Mk 11 (Target) Projectiles with Nylon Bands fired in Mk 11 Mod 2 Barrel No. 854063

Proj. No.	Firing Order	Lot No.	Firing Temp. (°F)	Powder Charge (grs.)	Muzzle Velocity (ft./sec.)	% Nominal Spin	Average Band Hardness R <sub>r</sub>		Band Diameter O.D. (ins.)		Condi- tioning		95° From Muzzle		115° From Muzzle		% Band on in Flight
							Before	After	Before	After	Before	After	From Muzzle	From Muzzle	From Muzzle	From Muzzle	
				IMR 6962			Condi- tioning	Condi- tioning	Condi- tioning	Condi- tioning	at +160°F	at +160°F					
2056	1	4A	-65	685	3251	104.73	103	107	.8278	.8285	5	2-1/2	3				100
2057	2	4A	-65	685	3251	104.73	104	108	.8276	.8285	0	0	0				100
2058	3	4A	-65	685	3262	105.34	103	107	.8276	.8282	0	4	4				90
2059	4	4A	-65	685	3252	105.34	102	108	.8275	.8288	4	0	0				100
2060	5	4A	-65	685	3249	104.57	103	107	.8275	.8287	3	3-1/2	2-1/2				100
2061	6	4A	-65	685	3238	--	105	107	.8275	.8285	3	3	2-1/2				100
2062	7	4A	-65	685	3292	--	102	106	.8275	.8283	0	0	0				100
2063	8	4A	-65	685	3212	--	103	108	.8276	.8286	0	0	0				100
2064	9	4A	-65	685	3249	--	102	108	.8275	.8286	2-1/2	2-1/2	C				100
2065	10	4A	-65	685	3232	--	102	106	.8275	.8287	0	0	0				90
2066	11	4B	-65	685	3243	105.01	102	108	.8272	.8280	0	0	0				100
2067	12	4B	-65	685	3238	104.70	102	104	.8271	.8282	0	0	0				100
2068	13	4B	-65	685	3290	104.75	102	106	.8277	.8286	4	4	2-1/2				Missed Picture
2069	14	4B	-65	685	3232	104.76	102	108	.8279	.8288	4	4	2-1/2				100
2070	15	4B	-65	685	3246	104.97	104	107	.8273	.8283	0	0	C				100
2071	16	4B	-65	685	3246	--	102	108	.8279	.8290	3	2-1/2	0				100
2072	17	4B	-65	685	3298	--	102	108	.8272	.8280	5	5	4				Missed Picture
2073	18	4B	-65	685	3240	--	103	107	.8273	.8281	0	0	0				100
2074	19	4B	-65	685	3226	--	103	107	.8278	.8287	0	0	0				100
2075	20	4B	-65	685	3238	--	103	107	.8279	.8290	2-1/2	2	2				100

Lot 4A Projectiles Type 2 Mod 2 according to APL 355B (Temp.: Mold +190°F, Proj. +160°F).

Lot 4B Projectiles Type 2 Mod 2 according to APL 355B (Temp.: Mold +60°F, Proj. +75°F).

Both lots of projectiles in temperature control at +160°F for 7 days, ambient 24 hours, and -65°F for a minimum of 4 hours. Approximately 30-45 seconds time out of cold box before firing.

TABLE 2

COMPLETE BEFORE AND AFTER FIRING DATA

Recovery Test of 20mm Mk 11 (Target) Projectiles with Nylon Bands in Mk 11 Mod 2 Barrel No. 854063

Proj. No.	Firing Order No.	Lot No.	Firing Temp. (°F)	Powder Charge (grs.) IMR-6962	Muzzle Velocity (ft./sec.)	% Nominal Spin	Average Band Hardness R		Band Diameter O.D. (ins.)		° Yaw		% Band on in Flight
							Before Conditioning	After Test	Before Conditioning	After Conditioning	115' From Muzzle	130' From Muzzle	
2095	1	4A	-65	685	3334	98.43	102	--	.8277	.8277	4	0	40
2096	3	4A	-65	685	3369	98.52	102	105	.8277	.8277	0	0	100
2097	5	4A	-65	685	3361	98.72	105	--	.8277	.8277	0	0	80
2098	7	4A	-65	685	3364	99.02	103	--	.8277	.8277	2-1/2	2-1/2	100
2099	9	4A	-65	685	3358	--	104	--	.8277	.8277	0	0	100
2100	11	4A	-65	685	3357	--	103	--	.8277	.8277	0	0	90
2101	13	4A	-65	685	3362	--	105	--	.8278	.8278	1	1	100
2102	15	4A	-65	685	3368	--	102	--	.8277	.8277	0	0	100
2103	17	4A	-65	685	3366	--	101	--	.8277	.8277	2-1/2	2-1/2	95
2104	19	4A	-65	685	3462	--	103	104	.8276	.8276	0	0	100
2105	2	4B	-65	685	3382	98.55	104	--	.8277	.8277	0	0	100
2106	4	4B	-65	685	3372	98.52	104	--	.8278	.8278	0	0	100
2107	6	4B	-65	685	3369	98.42	103	--	.8278	.8278	0	0	100
2108	8	4B	-65	685	3394	97.19	104	--	.8278	.8278	2-1/2	1	100
2109	10	4B	-65	685	3358	--	101	--	.8287	.8286	2	C	100
2110	12	4B	-65	685	3374	--	100	--	.8282	.8282	0	C	100
2111	14	4B	-65	685	3358	--	101	--	.8278	.8278	2-1/2	1	100
2112	16	4B	-65	685	3368	--	102	--	.8278	.8278	0	0	100
2113	18	4B	-65	685	3353	--	101	105	.8278	.8278	0	C	100
2114	20	4B	-65	685	3273	--	101	105	.8282	.8282	C	0	100

Lot 4A Projectiles Type 2 Mod 2 according to APL 355B (Temp.: Mold +190°F, Proj. +160°F).

Lot 4B Projectiles Type 2 Mod 2 according to APL 355B (Temp.: Mold +60°F, Proj. +75°F).

Both lots of projectiles in temperature control at -65°F for 4 hours, +160°F for 4 hours, ambient temperature for 16 hours. This cycle was repeated for 7 days. The projectiles were again subjected to -65°F for 4 hours and fired at that temperature.

COMPLETE BEFORE AND AFTER FIRING DATA

Recovery Test of 20mm Mk 11 (Target) Projectiles with Nylon Bands Fired in Mk 11 Mod 2 Barrel No. 854063

Proj. No.	Firing Order	Lot No.	Firing Temp. (°F)	Powder Charge (grs.) SPDN 10285	Muzzle Velocity (ft./sec.)	% Nominal Spin	Average Band Hardness Hr.		Band Diameter (ins.)		Difference of Diameters after Temp. Control		Yaw		% Band on After Recovery	In Flight
							Before	After	Before	After	Before	After	115° From Muzzle	130° From Muzzle		
2145	2	4A	+160	685	3388	96.8	102	89	.8277	.8314	+.0037		3	3	100	100
2146	4	4A	+160	685	3362	98.9	101	--	.8277	.8320	+.043		0	0	100	100
2147	6	4A	+160	685	3367	98.5	102	86	.8277	.8316	+.0039		2	2	100	100
2148	8	4A	+160	685	3373	--	102	90	.8280	.8318	+.0038		5	3	100	100
2149	10	4A	+160	685	3321	--	102	--	.8277	.8310	+.0033		2-1/2	3	100	100
2150	12	4A	+160	685	3352	--	--	--	--	--	--		2-1/2	2-1/2	100	100
2151	14	4A	+160	685	3352	--	--	85	--	--	--		4	2-1/2	100	100
2152	1	4B	+160	685	3361	95.0	102	80	.8272	.8320	+.0048		6	2-1/2	100	100
2153	3	4B	+160	685	3362	98.6	93	--	.8278	.8316	+.0038		3	0	100	100
2154	5	4B	+160	685	3352	98.5	103	--	.8281	.8322	+.0041		2-1/2	2-1/2	100	100
2155	7	4B	+160	685	3367	--	102	--	.8277	.8320	+.0043		5	3	100	100
2156	9	4B	+160	685	3326	--	101	85	.8277	.8320	+.0043		2-1/2	0	100	100
2157	11	4B	+160	685	3356	--	102	88	--	--	--		2-1/2	3	100	100
2158	13	4B	+160	685	3352	--	102	--	--	--	--		3	3	100	100
2159	15	4B	+160	685	3359	--	101	--	--	--	--		5	3	100	100
2160	16	4B	+160	685	3351	--	102	--	--	--	--		3	2-1/2	100	100
2161	17	4B	+160	685	3354	--	102	--	--	--	--		1	0	100	100

Lot 4A Projectiles Type 2 Mod 2 according to APL 355B (Temp.: Mold +190°F, Proj. +160°F).

Lot 4B Projectiles Type 2 Mod 2 according to APL 355B (Temp.: Mold +60°F, Proj. +75°F).

Projectiles subjected to +160°F temperature and 100% humidity for 7 days.

APPENDIX C

~~CONFIDENTIAL~~

NPG REPORT NO. 1342  
NAVORD REPORT NO. 1339

DESCRIPTION OF VELOCITY AND PRESSURE-TIME TEST

Ref: (c) NPG Conf Report No. 845 of 3 September 1951

1. Pressure-time curves were taken on rounds assembled with projectiles Type 2 Mod 2 (Nylon O $\frac{1}{2}$ 3 band O $\frac{1}{2}$ 828 diameter) and projectiles with Nylon O $\frac{1}{2}$ 3 band O $\frac{1}{2}$ 834 diameter (marked "SP"). Rounds assembled with projectiles Mk 11 Mod 0 were used for control.

2. All rounds were assembled as indicated in Table 4 from components on hand with the exception of the nylon projectiles. The nylon-banded projectiles were crimped in the case with the special crimp devised for these projectiles; the crimp for the gilding-metal-banded projectiles was standard. When fired, the projectile emergence was missed on the original projectiles with nylon rotating bands because the nylon was insulating the projectile from the barrel. Three more projectiles of each type were furnished and the muzzle exit recorded by the breaking of the muzzle wire. It will be noted that the rounds of one group of projectiles with nylon bands were fired alternately with those of the other group having nylon bands. Neither group was alternated with the group having copper bands. This was felt desirable to avoid any additional coppering of the barrel while these rounds were fired. All data were recorded by procedures covered in reference (c) except the projectile emergence times. All results are tabulated in Table 4. Typical pressure-time curves and a calibration are included as Figures 16 to 18 inclusive.

~~CONFIDENTIAL~~

TABLE 4

## TABULATED VELOCITY AND PRESSURE-TIME DATA

Nylon and Gilding Metal Band Comparison  
Piezo Gauge 13, Cell 4  
Barrel No. 862897 Chemically Decoppered  
672 Previous Rounds

Date	Time	Rd.	Powder		Projectile		Crimp (Tons)	Times (ms)		Muzzle Velocity (ft./sec.)	Piezo Pressure (psi)	
			Type	Lot	Weight (Grains)	Type		Ignition	Emergence		Peak	Muzzle Exit
10-23	1457	1	IMR 6962	DSZA-8	662	Mk 11 Mod 0	15	.53	2.02	*3268	*63,100	*11,200
10-23	1502	2	IMR 6962	DSZA-8	662	Mk 11 Mod 0	15			*3346		
10-23	1506	3	IMR 6962	DSZA-8	662	Mk 11 Mod 0	15	.51	2.04	3340	62,050	11,550
10-23	1510	4	IMR 6962	DSZA-8	662	Mk 11 Mod 0	15	.47	2.05	3338	59,900	10,900
10-23	1513	5	IMR 6962	DSZA-8	662	Mk 11 Mod 0	15	.50	2.03		60,050	11,400
10-23	1516	6	IMR 6962	DSZA-8	662	Mk 11 Mod 0	15	.50	2.03		59,550	10,250
10-23	1519	7	IMR 6962	DSZA-8	662	Mk 11 Mod 0	15	.49	2.01	3357	60,550	10,900
10-23	1523	8	IMR 6962	DSZA-8	662	Mk 11 Mod 0	15	.47	2.05	3333	59,800	10,850
		9										
			Averages					.49	2.04	3342	60,317	10,975
10-23	1527	10	IMR 7013	1A40302	620	T2-2 (Nylon	20	.47		3346	59,450	10,650
10-23	1536	12	IMR 7013	1A40302	620	Rotating Band	20					
10-23	1557	14	IMR 7013	1A40302	620	0.834 Dia.)	20	.50	1.99	3314	56,150	11,100
10-23	1604	16	IMR 7013	1A40302	620		20	.47		3292	54,050	
10-23	1612	18	IMR 7013	1A40302	620		20	.49		3316	56,775	
10-23	1625	20	IMR 7013	1A40302	620		20	.48		3331	57,000	
10-23	1637	22	IMR 7013	1A40302	620		20	.50		3362	62,350	
			Averages					.49	1.99	3327	57,629	10,875
10-23	1532	11	IMR 7013	1A40302	620	T2-2 (Nylon	20	.42			55,600	
10-23	1555	13	IMR 7013	1A40302	620	Rotating Band)	20	.47		3316	55,550	
10-23	1600	15	IMR 7013	1A40302	620		20	.50		3305	55,500	
10-23	1608	17	IMR 7013	1A40302	620		20	.48		3318	55,550	
10-23	1618	19	IMR 7013	1A40302	620		20	.49		3329	57,850	
10-23	1631	21	IMR 7013	1A40302	620		20	.44		3322	56,550	
10-23	1643	23	IMR 7013	1A40302	620		20	.51		3344	59,600	
			Averages					.47		3322	56,600	

\* Not included in average.

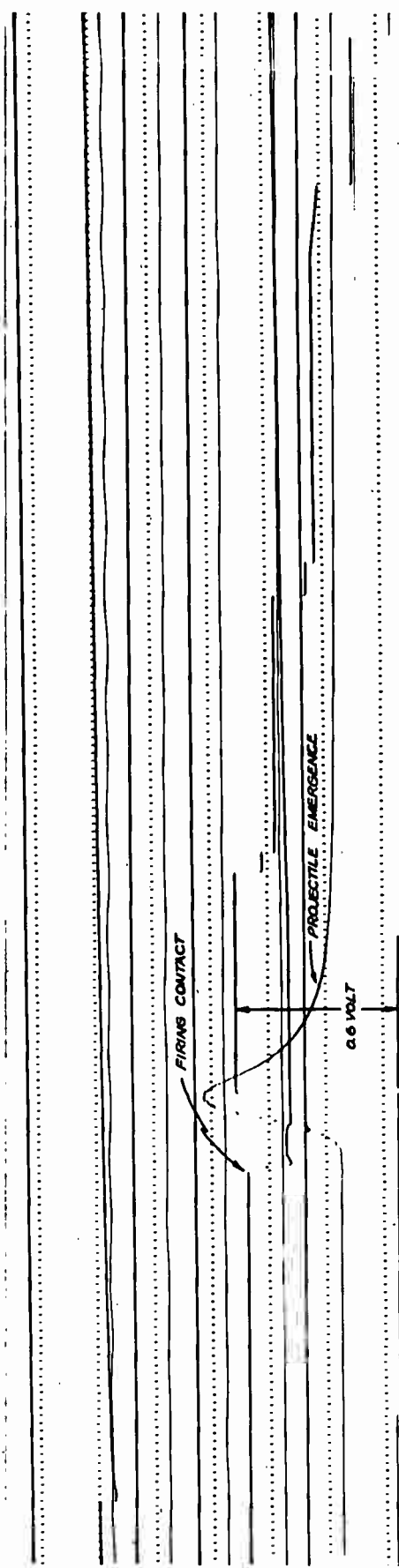
TABLE 4 (Continued)

Barrel No. 862904 Chemically Decoppered  
717 Previous Rounds

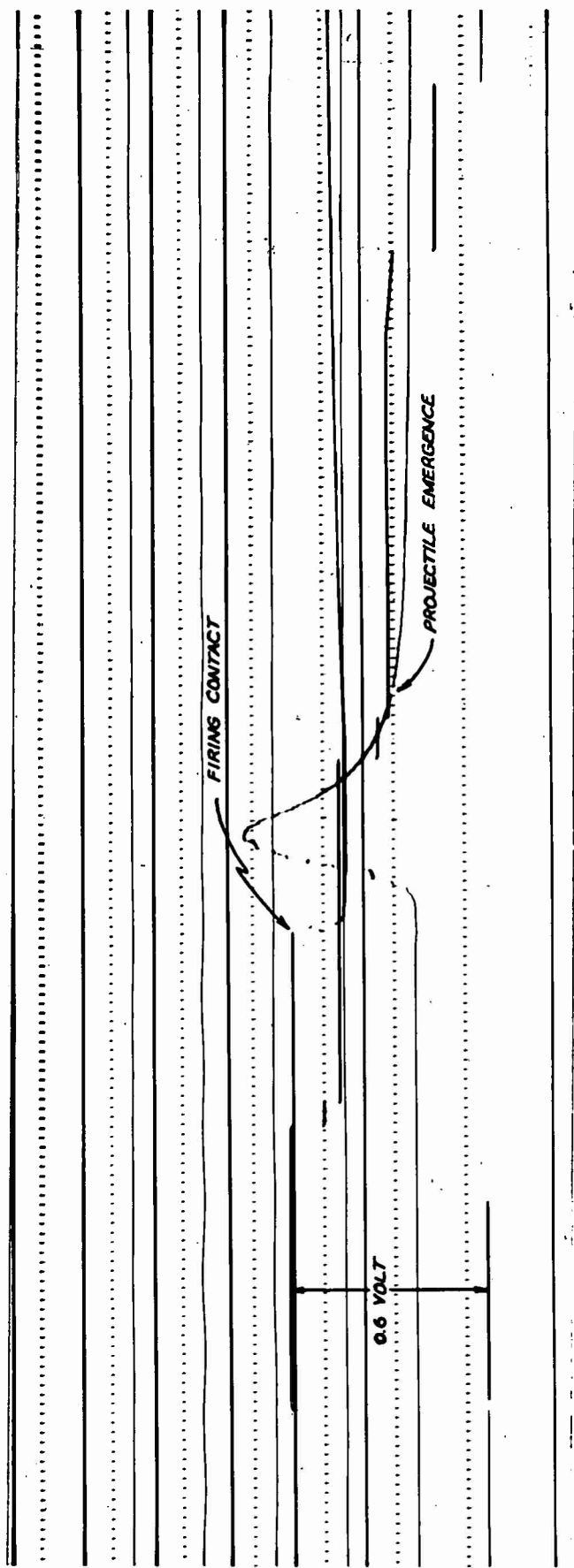
Date	Time	Rd.	Powder			Projectile		Crimp (Tons)	Times (ms)		Muzzle Velocity (ft./sec.)	Piezo Pressure (psi)	
			Type	Lot	Weight (Grains)	Type	Weight (Grains)		Ignition	Emergence		Peak	Muzzle Exit
11-24	1321	1	IMR 6962	DSZA-8	662	Mk 11 Mod 0		15	Warm-up	Warm-up			
11-24	1333	2	IMR 6962	DSZA-8	662	Mk 11 Mod 0		15	Warm-up	Warm-up			
11-24	1345	3	IMR 6962	DSZA-8	662	Mk 11 Mod 0		15	Warm-up	Warm-up			
11-24	1352	4	IMR 7013	1A40302	620	T2-2 (Nylon	1600.1	20	.45		3346	62,500	1,500
11-24	1412	6	IMR 7013	1A40302	620	Rotating Band	1596.1	20	.41		3329	61,000	10,000
11-25	1342	7	IMR 7013	1A40302	620	0°834 Dia.)	1601.8	20		2.21	3320	58,750	9,900
			Averages				1599.3		.43	2.21	3332	60,750	9,800
11-24	1405	5	IMR 7013	1A40302	620	T2-2 (Nylon	1600.8	20	.40	2.11	3286	57,800	10,300
11-24	1420	7	IMR 7013	1A40302	620	Rotating Band)	1598.3	20	.40	2.10	3270	56,200	10,475
11-25	1338	6	IMR 7013	1A40302	620		1602.8	20		2.22	3281	55,850	9,750
			Averages				1600.6		.40	2.14	3279	56,617	10,175
11-25	1345	8	IMR 6962	DSZA-8	662	Mk 11 Mod 0	1695.5	15	.45	2.17	3342	63,650	10,200
11-25	1354	9	IMR 6962	DSZA-8	662	Mk 11 Mod 0	1700.2	15	.45	2.17	3336	63,350	10,200
11-25	1357	10	IMR 6962	DSZA-8	662	Mk 11 Mod 0	1699.2	15	.49	2.15	3318	60,850	10,150
11-25	1400	11	IMR 6962	DSZA-8	662	Mk 11 Mod 0	1696.0	15	.49	2.16	3325	62,200	10,350
11-25	1404	12	IMR 6962	DSZA-8	662	Mk 11 Mod 0	1695.2	15	.45	2.16	3336	62,750	10,350
11-25	1407	13	IMR 6962	DSZA-8	662	Mk 11 Mod 0	1697.5	15	.50	2.10	3338	62,900	10,650
11-25	1411	14	IMR 6962	DSZA-8	662	Mk 11 Mod 0	1702.5	15	.44	2.16	3314	61,250	10,500
			Averages				1698.0		.47	2.15	3330	62,421	10,343

NPG REPORT NO. 1342  
NAVFORD REPORT NO. 1339





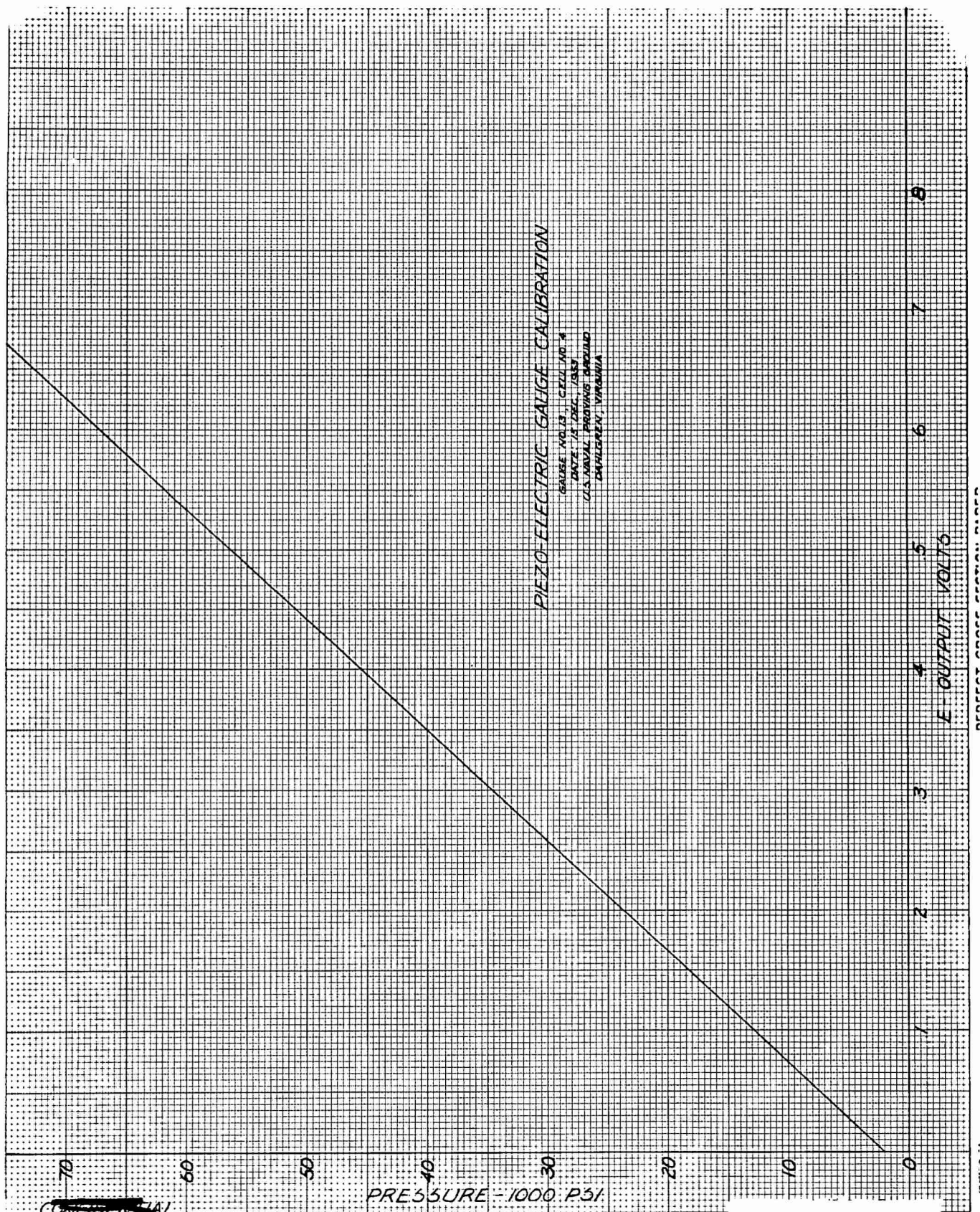
Page 10 of 10  
S. S.



MP9-64994  
Typical piezo pressure record of 20mm round assembled with Type 2 Mod 2 Modified Projectile (ball diameter 0.834). Time in 0.1 milliseconds.  
Figure 17

CONFIDENTIAL

APPENDIX C



NP9 64995

Figure 18

APPENDIX C

APPENDIX D

TABLE 5

## ACCURACY TEST, 600 FOOT RANGE FIRED IN NEW ACCURACY BARREL

7 August 1953

Rd. No.	Projectile Type	Powder Charge IMR 7013 (Grains)	Corrected Muzzle Velocity (ft./sec.)	Yaw at 38 Feet (Degrees)	Width of Pattern (ins.)	Height of Pattern (ins.)	Distance from Center of Impact Area (ins.)		Distance of Center of Impact Area from Bore Sight (ins.)		Standard Deviation at 600 Feet (ins.)	
							X	Y	X	Y	X	Y
1	T2-2 (Nylon Rotating Band) (Standard Crimp)	620	3297	3			+8.3	+2.7				
2		620	3302	5			+2.1	-6.6				
3		620	3266	2			-1.3	-4.7				
4		620	3327	4			-8.4	-2.9				
5		620	3320	2			+2.1	-5.2				
6		620	3290	5			-6.5	+6.7				
7		620	3331	5			+7.7	+5.3				
8		620	3292	4			-8.2	-5.9				
9		620	3299	4			-6.7	+3.3				
10		620	3314	2			-1.8	-6.8				
Average			3304		16.7	13.4			-3.3	-3.9	6.13	5.25
11	T2-2 (Nylon Rotating Band 0.823 Diameter) (Special Crimp)	620	3320	4			-2.9	-3.8				
12		620	3327	2			-2.9	+2.5				
13		620	3316	5			+6.6	-1.4				
14		620	3336	1			-4.4	+2.5				
15		620	3336	2			-4.5	+1.9				
16		620	3331	1			-6.6	+1.1				
17		620	3318	1			-3.6	+3.1				
18		620	3320	2			-3.3	+1.5				
19		620	3340	3			-3.1	-4.7				
20		620	3353	1			-2.9	+4.8				
Average			3330		13.1	9.5			+0.4	-12.9	4.33	3.04
21	T2-2 (Nylon Rotating Band) (Special Crimp)	620	3375	1			-4.1	-4.5				
22		620	3349	1			+1.0	-0.1				
23		620	3355	2			-3.5	-2.7				
24		620	3355	3			+3.9	-5.5				
25		620	3342	3			+1.2	-3.3				
26		620	3377	3			-5.4	-5.0				
27		620	3336	3			+0.7	-9.2				
28		620	3338	3			+3.4	+7.5				
29		620	3353	2			-1.0	+6.0				
30		620	3349	4			+5.4	+9.2				
Average			3353		10.7	18.4			-1.9	-10.0	3.34	6.03

 NPC REPORT NO. 1342  
 NAVORD REPORT NO. 1339

TABLE 5 (Continued)

Rd. No.	Projectile Type	Powder Charge IMR 7013 (Grains)	Corrected Muzzle Velocity (ft./sec.)	Yaw at 38 Feet (Degrees)	Width of Pattern (ins.)	Height of Pattern (ins.)	Distance from Center of Impact Area (ins.)		Distance of Center of Impact Area from Bore sight (ins.)		Standard Deviation at 600 Feet (ins.)	
							X	Y	X	Y	X	Y
31	T2-2 (Nylon Rotating Band) (Fired at -65°F) (Special Crimp)	620	--	2			+2.1	-1.4				
32		620	3217	2			+5.8	-1.6				
33		620	--	3			+0.2	-4.1				
34		620	--	1			-4.1	-0.7				
35		620	--	2			-5.7	-1.8				
36		620	3163	3			-4.6	+4.5				
37		620	3161	2			-3.5	-2.0				
38		620	--	2			-4.1	-3.2				
39		620	--	2			-0.8	-4.5				
40		620	--	2			-2.5	-2.4				
Average			3180		11.5	9.0			-3.2	-9.1	3.85	2.96
41	T2-2 (Nylon Rotating Band) 0.834 Diameter (Special Crimp)	620	3279	3			-3.3	-5.9				
42		620	--	3			+2.7	-3.5				
43		620	3264	1			+4.0	+3.8				
44		620	3264	2			+0.9	+2.5				
45		620	3295	2			-2.0	-1.3				
46		620	3270	1			+1.5	-1.4				
47		620	3275	3			+1.8	-2.7				
48		620	3275	1			-0.5	+0.7				
49		620	3286	3			-4.0	+6.9				
50		620	3288	3			-1.9	-4.8				
Average			3277		8.0	11.8			-6.9	-10.0	2.57	3.92
51	Reference Rounds, Mk 11 Mod C (Standard Crimp)	633	3373	3			+1.7	-0.8				
52		633	3351	3			-2.2	+0.5				
53		633	3377	3			-2.2	+0.7				
54		633	3344	4			+2.8	+0.3				
55		633	3362	2			-4.0	-2.5				
56		633	3366	3			-1.7	-1.5				
57		633	3353	2			-2.6	0.0				
58		633	3371	3			-2.4	+0.3				
59		633	3353	3			+0.7	-1.4				
60		633	3357	2			+4.0	+2.5				
Average			3361		8.0	5.1			-4.0	-9.5	2.63	1.38

CONFIDENTIAL

NPG REPORT NO. 1342  
NAWORD REPORT NO. 1339

11 March 1954

## ACCURACY TEST, 600 FOOT RANGE FIRED IN NEW ACCURACY BARREL

TABLE 6

Rd. No.	Projectile Type	Powder Charge IMR 7013 (Grains)	Corrected Muzzle Velocity (ft./sec.)	Yaw at 38 Feet (Degrees)	Yaw at 600 Feet (Degrees)	Distance from Center of Impact Area (ins.)		Distance of Center of Impact Area from Bore-sight (ins.)		Total Group Dispersion at 600 Feet (ins.)		Standard Deviation at 600 Feet (ins.)	
						X	Y	X	Y	X	Y	X	Y
1	Reference Rounds,	633	3324	1	0	-2.73	-0.60						
2	20mm Projectile	633	3299	0	0	+2.17	+0.47						
3	Mk 11 Mod 0	633	--	0	0	+1.33	-2.31						
4		633	3295	0	0	-3.84	-1.28						
5		633	3323	2	0	+3.32	+1.52						
6		633	3323	1	0	+3.84	+2.23						
7		633	3306	1	0	+1.58	+0.12						
8		633	3286	1	0	-0.16	-0.98						
9		633	3301	C	0	-0.65	+2.31						
10		633	3299	0	0	+0.78	+0.12						
Average			3306	0.6				+2.35	-2.28	7.68	4.62	2.468	1.524
11	T2-Mod 2 (Nylon	620	3255	1	0	+1.30	+0.10						
12	Rotating Band)	620	3267	0	0	-1.88	+2.18						
13		620	3263	0	0	-1.32	-2.15						
14		620	3263	0	0	-3.86	-0.22						
15		620	3293	2	0	+3.86	-5.63						
16		620	3265	0	0	-2.12	+4.34						
17		620	3257	0	0	-3.50	+0.90						
18		620	3265	2	0	-3.75	+2.42						
19		620	3274	2	0	+1.33	+5.63						
20		620	3255	0	0	-3.00	+2.17						
Average			3266	0.7				+5.75	-0.63	11.26	7.72	2.616	3.224
21	T2-Mod 6 (Nylon	620	3308	0	0	-1.23	-4.25						
22	Rotating Band)	620	3308	1	0	-6.42	-2.14						
23	0.784 Diameter	620	3299	2	0	+1.87	+7.95						
24	Aft of Band	620	3282	1	0	-3.67	-0.23						
25		620	3291	2	0	+6.62	+1.80						
26		620	3280	1	0	+8.73	-3.17						
27		620	3295	2	0	+4.40	-7.95						
28		620	3274	1	0	+1.22	+4.12						
29		620	3288	1	0	-8.73	-5.20						
30		620	3286	2	0	+2.02	+1.30						
Average			3291	1.3				+3.90	-3.75	17.46	15.90	5.563	4.738

TABLE 7

ACCURACY TEST, 1500-YARD RANGE FIRED IN NEW ACCURACY BARREL

22 and 26 August 1953

Date	Time	Rd. No.	Ammunition Lot Number and/or Projectile Type	Powder Charge (Grains)	Air Temp. (F)	Relative Humidity (%)	Wind Direction From Line of Fire	Wind Velocity (Knots)	Barometric Press at 21 Feet Above Sea Level (inches)	Ammunition Temp. (F)	Gun Elevation (Mils)	Missile First Screen (Feet)	Missile To Screen (Feet)	Distance Between Screens (Feet)	Instrumental Velocity (ft./sec.)	Time of Flight (Seconds)	Time of Flight (Seconds)	Diagonal Distance From Projectiles to Location (Feet)	Projectiles Height (Feet)	Hit Position (Feet)		Standard Deviation at 1500 Yards (Feet)
																				Horizontal	Vertical	
8-22	1413	1	Reference	633	80	48	--	0	1024.2	76	54104	30.095	49.965	3333	2.185	2.185	7.29	1702.3	10.92	4.36	4.36	
8-22	1415	2	Rounder 20mm	633	78 1/2	78 1/2	340	0	1024.2	76 1/2	54104	30.095	49.965	3333	2.185	2.185	7.29	1702.3	10.92	4.36	6.04	
8-22	1416	3	Projectile	633	78 1/2	78 1/2	340	0	1024.2	76 1/2	54104	30.095	49.965	3333	2.185	2.185	7.29	1702.3	10.92	4.36	2.09	
8-22	1421	4	Ms. 11 Mod 0	633	78	48	320	1	1024.2	77	54124	30.095	49.965	3333	2.185	2.185	7.29	1702.3	10.92	4.36	2.73	
8-22	1425	5		633	78	48	320	1	1024.2	77	54124	30.095	49.965	3333	2.185	2.185	7.29	1702.3	10.92	4.36	2.44	
8-22	1427	6		633	78	48	320	1	1024.2	77	54124	30.095	49.965	3333	2.185	2.185	7.29	1702.3	10.92	4.36	0.75	
8-22	1428	7		633	78	48	320	1	1024.2	77	54124	30.095	49.965	3333	2.185	2.185	7.29	1702.3	10.92	4.36	5.62	
8-22	1430	8		633	78	48	320	1	1024.2	77	54124	30.095	49.965	3333	2.185	2.185	7.29	1702.3	10.92	4.36	1.98	
8-22	1442	9		633	78 1/2	78 1/2	340	0	1024.2	77 1/2	54124	30.095	49.965	3333	2.185	2.185	7.29	1702.3	10.92	4.36	4.83	
8-22	1444	10		633	78 1/2	78 1/2	340	0	1024.2	77 1/2	54124	30.095	49.965	3333	2.185	2.185	7.29	1702.3	10.92	4.36	3.85	
8-22	1448	11		633	78 1/2	78 1/2	340	0	1024.2	77 1/2	54124	30.095	49.965	3333	2.185	2.185	7.29	1702.3	10.92	4.36	0.98	
8-22	1449	12		633	79 1/2	79 1/2	340	0	1024.2	78	54124	30.095	49.965	3333	2.185	2.185	7.29	1702.3	10.92	4.36	4.28	
8-22	1456	13		633	79 1/2	79 1/2	340	0	1024.2	78	54124	30.095	49.965	3333	2.185	2.185	7.29	1702.3	10.92	4.36	5.13	
8-22	1458	14		633	80 1/2	80 1/2	65	1	1023.3	78	54124	30.095	49.965	3333	2.185	2.185	7.29	1702.3	10.92	4.36	4.30	
8-22	1459	15		633	80 1/2	80 1/2	65	1	1023.3	78	54124	30.095	49.965	3333	2.185	2.185	7.29	1702.3	10.92	4.36	3.92	
8-22	1501	16		633	78 1/2	78 1/2	340	0	1023.3	78	54124	30.095	49.965	3333	2.185	2.185	7.29	1702.3	10.92	4.36	2.87	
8-22	1502	17		633	79	49	345	1	1023.3	78	54124	30.095	49.965	3333	2.185	2.185	7.29	1702.3	10.92	4.36	3.71	
8-22	1503	18		633	79 1/2	79 1/2	340	0	1023.3	78	54124	30.095	49.965	3333	2.185	2.185	7.29	1702.3	10.92	4.36	0.77	
8-22	1505	19		633	79 1/2	79 1/2	340	0	1023.3	78	54124	30.095	49.965	3333	2.185	2.185	7.29	1702.3	10.92	4.36	4.87	
8-22	1506	20		633	80 1/2	80 1/2	30	1	1023.3	78	54124	30.095	49.965	3333	2.185	2.185	7.29	1702.3	10.92	4.36	4.54	
8-22	1508	21		633	80 1/2	80 1/2	30	1	1023.3	78	54124	30.095	49.965	3333	2.185	2.185	7.29	1702.3	10.92	4.36	5.23	
8-22	1509	22		633	80 1/2	80 1/2	30	1	1023.3	78	54124	30.095	49.965	3333	2.185	2.185	7.29	1702.3	10.92	4.36	5.23	
8-22	1512	23		633	79	48	--	0	1023.3	78	54124	30.095	49.965	3333	2.185	2.185	7.29	1702.3	10.92	4.36	0.51	
8-22	1512	24		633	79	48	--	0	1023.3	78	54124	30.095	49.965	3333	2.185	2.185	7.29	1702.3	10.92	4.36	0.51	
8-22	1513	25		633	79	48	--	0	1023.3	78	54124	30.095	49.965	3333	2.185	2.185	7.29	1702.3	10.92	4.36	5.37	
8-22	1515	26		633	79	48	--	0	1023.3	79	54124	30.095	49.965	3333	2.185	2.185	7.29	1702.3	10.92	4.36	1.842	
8-26	1035	1		620	82 1/2	55	--	0	1021.9	79	56100	30.090	50.025	3293	2.242	2.242	9.60	1607	5.68	18.63	18.63	
8-26	1039	2		620	82 1/2	55	210	0	1021.9	79	56100	30.090	50.025	3293	2.242	2.242	9.60	1607	5.68	18.63	7.99	
8-26	1041	3		620	83	55	--	0	1021.9	79	56100	30.090	50.025	3293	2.242	2.242	9.60	1607	5.68	18.63	7.99	
8-26	1043	4		620	83	55	165	0	1021.9	79	56100	30.090	50.025	3293	2.242	2.242	9.60	1607	5.68	18.63	5.41	
8-26	1045	5	Bylam Rotating Band, O-828 Diameter	620	83	55	--	0	1021.9	79	56100	30.090	50.025	3298	2.242	2.242	9.60	1607	5.68	18.63	5.18	
8-26	1047	6		620	83	55	--	0	1021.9	79	56100	30.090	50.025	3298	2.242	2.242	9.60	1607	5.68	18.63	15.79	
8-26	1051	7		620	84	55	--	0	1021.9	79	56100	30.090	50.025	3302	2.242	2.242	9.60	1607	5.68	18.63	13.76	
8-26	1053	8		620	84	55	320	0	1021.9	79	56100	30.090	50.025	3306	2.242	2.242	9.60	1607	5.68	18.63	6.46	
8-26	1055	9		620	84	55	320	0	1021.9	79	56100	30.090	50.025	3315	2.242	2.242	9.60	1607	5.68	18.63	2.27	
8-26	1057	10		620	84	55	230	0	1021.9	79	56100	30.090	50.025	3317	2.242	2.242	9.60	1607	5.68	18.63	10.69	
8-26	1059	11		620	84	55	--	0	1021.9	79	56100	30.090	50.025	3324	2.242	2.242	9.60	1607	5.68	18.63	15.64	
8-26	1113	12		620	84	55	--	0	1021.9	79	56100	30.090	50.025	3329	2.242	2.242	9.60	1607	5.68	18.63	5.59	
8-26	1115	13		620	84	55	230	0	1021.9	79	56100	30.090	50.025	3335	2.242	2.242	9.60	1607	5.68	18.63	11.01	
8-26	1117	14		620	84	55	--	0	1021.9	79	56100	30.090	50.025	3339	2.242	2.242	9.60	1607	5.68	18.63	12.38	
8-26	1119	15		620	84	55	--	0	1021.9	79	56100	30.090	50.025	3309	2.242	2.242	9.60	1607	5.68	18.63	8.52	
8-26	1120	16		620	85	55	--	0	1021.9	79	56100	30.090	50.025	3309	2.242	2.242	9.60	1607	5.68	18.63	14.25	
8-26	1122	17		620	85	55	--	0	1021.9	79	56100	30.090	50.025	3322	2.242	2.242	9.60	1607	5.68	18.63	5.78	
8-26	1125	18		620	85	55	--	0	1021.9	79	56100	30.090	50.025	3322	2.242	2.242	9.60	1607	5.68	18.63	12.14	
8-26	1127	19		620	86	55	--	0	1021.9	79	56100	30.090	50.025	3326	2.242	2.242	9.60	1607	5.68	18.63	6.75	
8-26	1130	20		620	86 1/2	55	160	0	1021.9	79	56100	30.090	50.025	3298	2.242	2.242	9.60	1607	5.68	18.63	7.44	
8-26	1133	21		620	86 1/2	55	--	0	1021.9	79	56100	30.090	50.025	3291	2.242	2.242	9.60	1607	5.68	18.63	14.13	
8-26	1135	22		620	86 1/2	55	--	0	1021.9	79	56100	30.090	50.025	3291	2.242	2.242	9.60	1607	5.68	18.63	9.18	
8-26	1137	23		620	86 1/2	55	--	0	1021.9	79	56100	30.090	50.025	3313	2.242	2.242	9.60	1607	5.68	18.63	12.73	
8-26	1139	24		620	86 1/2	55	--	0	1021.9	79	56100	30.090	50.025	3313	2.242	2.242	9.60	1607	5.68	18.63	7.28	
8-26	1141	25		620	86 1/2	55	--	0	1021.9	79	56100	30.090	50.025	3313	2.242	2.242	9.60	1607	5.68	18.63	4.93	
8-26	1142	26		620	86 1/2	55	--	0	1021.9	79	56100	30.090	50.025	3313	2.242	2.242	9.60	1607	5.68	18.63	7.94	
8-26	1143	27		620	86 1/2	55	--	0	1021.9	79	56100	30.090	50.025	3322	2.242	2.242	9.60	1607	5.68	18.63	15.43	
8-26	1145	28		620	86 1/2	55	--	0	1021.9	79	56100	30.090	50.025	3322	2.242	2.242	9.60	1607	5.68	18.63	4.93	
8-26	1147	29		620	86 1/2	55	--	0	1021.9	79	56100	30.090	50.025	3320	2.242	2.242	9.60	1607	5.68	18.63	7.94	
8-26	1149	30		620	86 1/2	55	--	0	1021.9	79	56100	30.090	50.025	3320	2.242	2.242	9.60	1607	5.68	18.63	13.79	
8-26	1151	31		620	86 1/2	55	--	0	1021.9	79	56100	30.090	50.025	3387	2.242	2.242	9.60	1607	5.68	18.63	2.77	
8-26	1152	32		620	86 1/2	55	--	0	1021.9	79	56100	30.090	50.025	3289	2.242	2.242	9.60	1607	5.68	18.63	13.50	
8-26	1154	33		620	86 1/2	55	--	0	1021.9	79	56100	30.090	50.025	3364	2.242	2.242	9.60	1607	5.68	18.63	8.25	
8-26	1155	34		620	86 1/2	55	--	0	1021.9	79	56100	30.090	50.025	3364	2.242	2.242	9.60	1607	5.68	18.63	10.58	
8-26	1156	35		620	86 1/2	55	--	0	1021.9	79	56100	30.090	50.025	3315	2.242	2.242	9.60	1607	5.68	18.63	7.84	
8-26	1157	36	</																			



TABLE 7 (Continued)

Date	Time	Ed. No.	Ammunition Lot Number and/or Projectile Type	Powder Charge IIR 7013 (Grains)	Air Temp.	Relative Humidity (%)	Wind Direction of Fire	Wind Velocity (knots)	Barometric Pressure at 21 Feet Above Level (inches)	Amn. Temp. °F	Cum. Elev. Ft.	Muzzle to First Screen (Feet)	Distance Between Screens (Feet)	Instrumental Velocity (ft./sec.)	Time of Flight to Target (Seconds)	Time to Projectile Location (Seconds)	Projectile Weight (Grains)	Hit Position (Feet)	Standard Deviation at 500 Yards (Feet)
																		Horizontal	Vertical
8-26	1239	1	T2-2 (Nylon Rotating Band, 01834 Diam-eter)	620	88 1/2	47	--	0	1021.2	82 1/2	57106	30,030	50,025	3278	2,300	7.88	1605	5.09	6.91
8-26	1241	2		620	88 1/2			2		84	57106			3287	2,217	7.15	1608	7.62	5.13
8-26	1243	3		620	88 1/2		315	2		84	57106			3274	2,275	8.71	1604	9.16	2.87
8-26	1245	4		620	88 1/2		315	4		84	57106			3286	2,218	6.11	1604	6.13	7.82
8-26	1246	5		620	88 1/2		315	4		84	57106			3287	2,286	5.48	1600	13.87	9.56
8-26	1248	6		620	88 1/2		315	4		84 1/2	57106			3263	2,253	7.48	1607	7.86	7.29
8-26	1250	7		620	88 1/2		315	2		84 1/2	57106			3293	2,230	1.70	1605	10.04	10.75
8-26	1251	8		620	88 1/2	47	305	4	1021.2	84 1/2	57106			3263	2,289	6.32	1602	8.22	5.90
8-26	1252	9		620	87 1/2		305	4		84 1/2	57106			3276	2,238	5.01	1605	6.83	9.84
8-26	1255	10		620	87 1/2		300	4		84 1/2	57106			3280	2,279	8.72	1605	4.08	6.96
8-26	1257	11		620	87 1/2		315	3		84 1/2	57106			3291	2,218	4.53	1605	7.96	5.15
8-26	1259	12		620	87 1/2		320	2		84 1/2	57106			3274	2,271	3.36	1604	5.15	11.43
8-26	1301	13		620	88 1/2	47	325	2	1021.2	84 1/2	57106			3287	2,321	3.79	1602	13.64	14.39
8-26	1303	14		620	88 1/2		325	2		85	57106			3272	2,321	5.86	1602	5.95	10.22
8-26	1305	15		620	88 1/2		340	3		85	57106			3295	2,232	4.30	1594	9.19	7.94
8-26	1306	16		620	88 1/2		340	2		85	57106			3293	2,247	6.19	1610	6.43	7.94
8-26	1308	17		620	88 1/2		340	2		85	57106			3304	2,287	7.78	1595	3.96	12.04
8-26	1312	18		620	88 1/2		310	3		85	57106			3293	2,287	3.99	1602	10.01	8.01
8-26	1314	19		620	88 1/2		325	4		85	57106			3291	2,311	10.12	1595	5.13	3.50
8-26	1316	20		620	88 1/2		325	4		85	57106			3295	2,256	6.81	1606	6.00	7.47
8-26	1317	21		620	88 1/2		330	2		85	57106			3285	2,263	2.68	1605	9.95	13.18
8-26	1319	22		620	88 1/2		330	3		85	57106			3282	2,249	6.52	1600	5.27	10.07
8-26	1321	23		620	88 1/2		305	3		85	57106			3289	2,244	4.91	1600	8.00	7.96
8-26	1321	24		620	88		290	4		85	57106			3304	2,229	3.49	1597	8.70	12.96
8-26	1322	25		620	88		290	4		85	57106			3302	2,211	6.01	1604	6.09	9.04
																		2.556	2.846
8-26	1357	1	T2-2 (Nylon Rotating Band, 01836 Diam-eter)	620	89		330	3		87	56136	30,030	50,025	3326	2,170	3.50	1602	8.27	10.37
8-26	1402	2		620	88 1/2	41	320	4	1020.8	87 1/2	56136			3278	2,227	3.67	1602	11.25	11.25
8-26	1404	3		620	89		305	4		87 1/2	56136			3346	2,160	6.18	1603	6.35	14.25
8-26	1406	4		620	89		305	6		87 1/2	56136			3355	2,150	7.81	1607	5.60	16.05
8-26	1409	5		620	90		325	1		87 1/2	56136			3346	2,160	4.04	1600	10.88	15.09
8-26	1411	6		620	89 1/2		320	4		87 1/2	56136			3293	2,222	5.80	1595	7.95	6.76
8-26	1411	7		620	89		20	2		88	56136			3342	2,180	3.86	1600	8.00	10.10
8-26	1418	8		620	89		20	3		88	56136			3295	2,224	1.85	1602	10.55	10.55
8-26	1420	9		620	89 1/2		5	4		88	56136			3353	2,141	6.05	1598	6.31	13.94
8-26	1422	10		620	90		325	2		88	56136			3339	2,172	9.16	1624	3.07	14.22
8-26	1425	11		620	90		320	2		88	56136			3331	2,151	3.74	1600	7.98	11.47
8-26	1428	12		620	89 1/2		320	4		88	56136			3326	2,189	7.63	1602	4.30	13.01
8-26	1430	13		620	90		355	3		88	56136			3348	2,160	8.96	1602	3.12	13.70
8-26	1435	14		620	90		0	4		89	56136			3360	2,145	5.54	1605	6.24	10.16
8-26	1457	15		620	90		0	1		89	56136			3328	2,194	10.62	1610	11.13	11.13
8-26	1459	16		620	91		0	1		89	56136			3342	2,172	3.07	1602	10.24	8.49
8-26	1502	17		620	91	47	340	3	1020.3	89	56136			3346	2,169	9.19	1605	2.97	11.94
8-26	1504	18		620	91		5	3		89	56136			3355	2,150	4.95	1595	7.00	12.72
8-26	1505	19		620	90 1/2		335	4		89	56136			3355	2,151	8.45	1602	5.35	16.71
8-26	1514	20		620	90		335	2		89 1/2	56136			3348	2,144	7.92	1603	5.98	16.63
8-26	1514	21		620	90 1/2		330	5		89 1/2	56136			3359	2,205	2.174	1597	7.76	16.49
8-26	1517	22		620	90		335	2		90	56136			3274	2,245	7.89	1597	3.82	10.81
8-26	1525	23		620	90 1/2		0	5		90	56136			3274	2,245	5.52	1604	8.17	6.95
8-26	1528	24		620	90 1/2		0	2		90	56136			3369	2,137	9.13	1602	4.76	17.10
8-26	1531	25		620	90		310	3		90	56136			3346	2,158	2.06	1598	11.29	9.16
																		2.707	3.019

APPENDIX E

DATA PERTAINING TO THE RAPID-FIRE GUN LIFE TESTSGun

The 20mm aircraft gun Mk 12 Mod 0 used in these tests, which fires at a rate of approximately 1000 rounds per minute, was mounted on a stationary mount for normal rapid-fire operation.

Barrel

The 20mm Mk 11 Mod 2 barrels fired in these tests were either chrome plated with 0.0006 hard chrome, chamber and bore, or unplated. The rifling had uniform twist of 1 turn in 25.587 calibers, and a uniform depth of .015.

Round Assembly

The 20mm Mk 11 Mod 0 (Target) projectiles, both standard and modified (nylon band and extra crimping groove) were assembled in Mk 5 steel cases with Mk 47 primers (with one exception; the primer Mk 4 was used in Barrel No. 856686). The standard projectiles were rubber crimped at a pressure of 15 tsi and the modified projectiles at 20 tsi pressure. The nose plugs were standard pointed dummy nose plugs.

Powder

The propellant, IMR 7013 Lots CDZA-1 and CDZA-3 (the latter also designated as 1A-40302), was a 20mm NH production powder. The two lots were of the same series, having the same nominal composition and granulation and the same approximate flame temperature (2880°K).

Yaw

The projectile yaw in degrees was measured at 1000 inches from the gun by means of a traveling paper screen. Actual degrees of yaw for each round was determined by measuring the maximum diameter of the hole cut in this screen.

~~CONFIDENTIAL~~

NPG REPORT NO. 1342  
NAVORD REPORT NO. 1339

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### Dispersion

The dispersion was measured at 1092 inches from the gun by means of a stationary cardboard target, and is expressed in terms of the horizontal and vertical dimensions in inches of the rectangle on the target enclosing all the impacts in one burst (approximately 50 rounds).

### Velocity

The velocity measurements were taken for each round by means of a Potter recording counter chronograph. The magnetizing coil was placed at the muzzle of the gun and the velocity measured by means of coils placed at 30 and 80 feet from the muzzle.

### Barrel Inspection

The barrels were inspected by observing the rifling and chamber before and after each cycle was fired with a borescope. Photographs were taken at points of interest, before and after firing each cycle, of the barrels firing nylon bands and after each cycle of some of the barrels firing gilding metal bands. The barrels, rifling and chamber, were gauged before and after firing each cycle. Each diameter at a dimension from the gauging plane was gauged three times on three different sets of lands or grooves.

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APPENDIX F

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TABLE 8  
TABULATED FIRING DATA

Date Fired: 21 May 1953  
20mm Aircraft Gun Mk 12 Mod 0 Serial No. 500056  
20mm Barrel Mk 11 Mod 2 Serial No. EX-184, Chrome Plated (No Previous Rounds)  
Projectiles: Type 2 Mod 2 (Nylon Bands Lot S2A)  
Propellant: 670 grains of IMR 7CL3, Lot 1A40302 Powder

Burst	Time	Belted	Fired	Rds. on Barrel	Cyclic Rate (rpm)	Muzzle Velocity (ft./sec.)	Yaw (Degrees)*						Dispersion	
							C-5	6-10	11-15	Over 15	No.	Rds.	100% Pattern	
							No.	No.	No.	No.			(ins.)	
							Rds.	Rds.	Rds.	Rds.			X	Y
1	1111	50	50	50	1041	3428±13	31	12	4	3			(	
2	1113	50	50	100	1037	3416±13	30	10	6	4	**		(21.9	23.0
3	1115	50	50	150	1034	3420±15	14	13	12	11				
4		50	1)		--								--	--
4	1117	47	47)	198	1030	3410±17	14	12	9	13			--	--
5	1119	50	50	248	1029	3403±15	10	8	11	21			--	--
6	1121	50	50	298	1028	3406±19	11	6	15	18			--	--
7	1123	50	50	348	1021	3424±26	15	10	12	13			22.1	26.9
8	1125	50	50	398	1010	3408±19	16	8	6	20			26.5	27.0
9	1128	50	50	448	1014	3401±19	25	4	10	11			25.2	24.2
10	1130	50	17)										21.2	26.1
10	1130	33	33)	498	998	3398±26	21	4	10	15			25.9	24.6
11	1132	50	50	548	1015	3419±20	33	5	3	8			**	(26.1
12	1134	50	50	598	1004	3407±20	23	5	11	11				27.3

NOTES: Gun stoppage Bursts 4 and 10 due to feeder failure.

\* Rounds omitted could not be measured.

\*\* An average single-burst-pattern size was calculated statistically from the total pattern size.

The statistical average for first three bursts - Horizontal 18.6, Vertical 19.5.

The statistical average for last two bursts - Horizontal 23.4, Vertical 24.5.

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NPG REPORT NO. 1342  
NAVORD REPORT NO. 1339TABLE 2  
TABULATED FIRING DATA

Date Fired: 18 September 1953  
 20mm Aircraft Gun Mk 12 Mod C Serial No. 501151  
 20mm Barrel Mk 11 Mod 2 Serial No. EX-184 Chrome Plated (998 Previous Rounds)  
 Projectiles: Type 2 Mod 2 (Nylon Bands Lot S2B)  
 Propellant: 620 grains IMR 7013, Lot 1A-40302 Powder

Burst	Time	Belted	Fired	Rds. on Barrel	Cyclic Rate (rpm)	Average Velocity (ft./sec.)	Yaw (Degrees)						Dispersion 100% Pattern (ins.)		Remarks		
							0-5		6-10		11-15		16-35			X	Y
							No.	Rds.	No.	Rds.	No.	Rds.	No.	Rds.			
1	1427	50	46	644	967	3270±13	33	8	3	2		18.3	16.3	Slow feed.			
2	1429	50	50	694	976	3253±10	36	3	11			16.8	17.1				
3	1431	50	43)		978									Slow feed.			
3	1432	7	7)	744	--	3256±14	19	11	13	7		19.4	20.1				
4	1434	50	50	794	971	3238±17	19	13	7	11		19.7	23.0				
5	1436	50	50	844	976	3249±15	15	8	13	14		23.0	23.8				
6	1438	50	31)		976									Slow feed.			
6	1439	19	7)		--									Slow feed.			
6	1439	11	11)	893	--	3241±18	16	10	10	13		19.8	21.2				
7	1441	50	50	943	958	3242±15	19	13	12	6		19.5	20.6	Shorted primer.			
8	1445	50	35)		952												
8	1445	13	13)	991		3248±17	22	11	11	4		21.3	21.9				
9	1446	50	50	1041	952	3255±17	22	7	15	6		22.1	19.7				
10	1448	50	50	1091	950	3252±15	16	8	11	15		24.8	23.1				
11	1450	53	52	1143	948	3240±18	18	10	12	12		22.7	20.6	Defective end link.			
12	1452	51	51	1194	943	3245±20	24	5	8	14		22.7	21.6				

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TABLE 10

TABULATED FIRING DATA

Date Fired: 23 April 1954  
20mm Aircraft Gun Mk 12 Mod 0 Serial No. 500201  
20mm Barrel Mk 11 Mod 2 Serial No. EX-184 Chrome Plated (1194 Previous Rounds)  
Projectiles: Type 2 Mod 2 (Nylon Bands Lot S9)  
Propellant: 620 grains IMR 7013, Lot 1A-40302 Powder

Burst	Time	Beltd	Fired	Rds. on Barrel	Cyclic Rate (rpm)	Average Velocity (ft./sec.)	Yaw (Degrees)			Dispersion 100% Pattern (ins.)	Remarks
							0-5 No. Rds.	6-10 No. Rds.	11-15 No. Rds.		
	1102	15	15	1209	1014	3272±10					
1	1415	50	18	1227	1025	3276±12	49			11.5 16.4	Cold velocity. Last 10 rounds of burst figured for average. Broken firing pin.
2	1417	31	31	1258	1016	3266±14	32	9	8	15.4 14.5	
3	1419	50	50	1308	1037	3236±15	28	19	3	12.1 15.9	
4	1421	50	50	1358	1032	3230±14					Breech block out of battery.
4	1423	50	34	1392	1023	3236±20					
4	1424	15	15	1407	1019	3241±17	46	1	1	19.0 17.4	
5	1426	50	50	1457	1014	3237±19	46	3	1	13.8 16.8	Belt separation.
6	1428	50	50	1507	1005	3235±17	38	11	1	21.1 16.6	
7	1430	50	50	1557	997	3239±19	41	5	3	18.1 20.1	
8	1432	50	50	1607	987	3240±18	39	8	3	17.6 16.0	Cold velocity. Last 10 rounds of burst figured for average.
9	1434	50	50	1657	977	3243±18	37	10	3	20.3 17.2	
10	1436	50	23	1680	985	3231±23					
10	1438	27	27	1707	965	3220±19	41	7	1	21.6 19.3	
11	1440	50	50	1757	960	3238±19	43	5	1	21.4 17.1	
12	1442	50	50	1807	960	3240±20	43	3	**1	17.0 23.1	
		*15	15	1822	977	3241±10					

\* Gun at Ambient Temperature.  
\*\* 1st round in burst.



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NPG REPORT NO. 1342  
NAVORD REPORT NO. 1339

TABULATED FIRING DATA

TABLE 11

Date Fired: 16 July 1954  
20mm Aircraft Gun Mk 12 Mod 0 Serial No. 501152  
20mm Barrel Mk 11 Mod 2 Serial No. EX-184 Chrome Plated (1832 Previous Rounds)  
Projectiles: Type 2 Mod 2 (Nylon Bands, Lots S9, S10, and S10M)  
Propellant: 620 grains IMR 7013, Lot 1A-4C302 Powder

Burst	Time	Beltd	Fired	Rds. on Barrel	Cyclic Rate (rpm)	Average Velocity (ft./sec.)	Rotating Band Lot	Yaw (Degrees)*						Dispersion		Remarks		
								0-5		6-10		11-15		Over 15			100% Pattern	
								No.	Rds.	No.	Rds.	No.	Rds.	No.	Rds.		(ins.)	X
	0950	10	10	1842	1023(5 rds)	3238±8	S10											
					(5 rds)	3236±7	S10M	10										
1	0959	50	50	1892	1049	3228±12	S10M	38	1	2		1	11.1	14.2				
2	1023	50	50	1942	1058	3225±16	S10	45	3	1			16.7	14.3				
3	1025	50	50	1992	1012	3237±13	S10	50					15.3	18.5				
4	1027	50	50	2042	1041	3209±20	S10M	48	1	1			21.4	19.1				
5	1029	50	31	2073	1025	3224±19												Rd. in chamber - bolt out of battery.
5	1030	18	18	2091	1016	3219±18	S10	47	1	1			17.9	18.0				Rd. in chamber - bolt out of battery.
6	1031	50	36	2127	1017	3220±14												
6		13	13	2141	1000	3208±22	S10	45	1			3	19.8	17.3				
7	1034	50	50	2191	1003	3216±20	S10	44	3	3			23.1	20.0				
8	1036	50	37	2228	996	3219±20												Rd. in chamber - bolt out of battery.
8		12	12	2241	994	3207±8	S10M	45	2	1		1	23.3	18.3				
9	1037	50	11	2252	1000	3213±25												Rd. in chamber - bolt out of battery.
9	1039	38	38	2290	984	3223±17	S9	47	2				17.6	19.9				
10	1041	50	50	2340	980	3230±18	S10	45	1	1		1	21.4	19.8				
11	1043	50	40	2380	973	3235±13												Rd. in chamber - bolt out of battery.
11		9	9	2389	984	3217±15	S10	46	2			2	22.2	16.7				
12	1056	50	24	2413	965	3225±19												
12	1060	26	26	2439	965	3226±20	S10	47		3			23.1	20.2				
		**25	25	2464	984(10 rds)	3260±14	S9											
					(10 rds)	3251±6	S10M											
					(5 rds)	3261±13	S10											

NOTE: Bands of Lot S10M were machined to 0.823 diameter, others as molded at 0.828.

\* Rounds omitted could not be measured.

\*\* Gun at Ambient Temperature.

TABLE 12

20mm Barrel Mk 11 Mod 2 Serial EX-184 Chrome Plated.

## BARREL MEASUREMENT DATA

Distance from Breech Surface (ins.)	Diameters (ins.)									
	Bore (QF787-QF002-QF000)					Grooves (QF817-QF004-QF000)				
	Prior Firing	After Firing	Prior Firing	After Firing	Prior Firing	After Firing	Prior Firing	After Firing	Prior Firing	After Firing
	598 Rds.	1194 Rds.	1822 Rds.	2464 Rds.	598 Rds.	1194 Rds.	1822 Rds.	2464 Rds.	598 Rds.	1194 Rds.
4.75	.7875	.789	.791	.791	.7885	.789	.792	.792	.7875	.7915
5.00	.787	.786	.787	.787	.786	.7865	.787	.787	.7865	.787
6.00	.787	.785	.7855	.7855	.785	.7845	.7855	.7855	.785	.786
7.00	.7875	.7845	.7845	.7845	.7845	.7845	.7845	.7845	.7845	.7845
8.00	.7875	.785	.785	.785	.785	.7845	.785	.785	.7845	.785
9.00	.7875	.785	.785	.785	.7845	.7845	.785	.785	.7845	.785
10.00	.7875	.785	.7855	.7855	.7845	.7845	.7855	.7855	.7845	.785
15.00	.787	.786	.7865	.7865	.7855	.7855	.7865	.7865	.7855	.786
20.00	.787	.7865	.7875	.7875	.786	.786	.7875	.7875	.7865	.787
25.00	.787	.787	.7875	.7875	.787	.787	.7875	.7875	.7865	.7875
30.00	.787	.787	.788	.788	.7875	.788	.7885	.7885	.7875	.7885
35.00	.787	.787	.788	.788	.7875	.788	.7885	.7885	.7875	.7885
40.00	.7865	.7865	.788	.788	.7865	.7865	.7875	.7875	.7865	.7875
45.00	.787	.788	.7895	.7895	.787	.788	.789	.789	.7875	.7895
46.00	.787	.788	.789	.789	.7875	.7875	.789	.789	.7875	.7885
47.00	.7865	.7875	.7885	.7885	.787	.7875	.789	.789	.7875	.788
48.00	.7865	.7875	.7885	.7885	.7875	.7875	.789	.789	.7875	.7885
49.00	.786	.7875	.7885	.7885	.7875	.7875	.789	.789	.7875	.789
50.00	.786	.787	.7885	.7885	.786	.787	.788	.788	.7875	.7885
51.00	.786	.787	.788	.788	.7855	.7865	.788	.788	.787	.788
52.00	.7855	.789	.7905	.7905	.789	.7895	.791	.791	.7895	.791
52.25	.7855	.7895	.791	.791	.7895	.7895	.791	.791	.7895	.791

Distance from Breech Surface (ins.)	Diameters (ins.)									
	Bore (QF787-QF002-QF000)					Grooves (QF817-QF004-QF000)				
	Prior Firing	After Firing	Prior Firing	After Firing	Prior Firing	After Firing	Prior Firing	After Firing	Prior Firing	After Firing
	598 Rds.	1194 Rds.	1822 Rds.	2464 Rds.	598 Rds.	1194 Rds.	1822 Rds.	2464 Rds.	598 Rds.	1194 Rds.
4.75	.821	.817	.8175	.8175	.821	.817	.8175	.8175	.822	.817
5.00	.821	.818	.817	.817	.821	.817	.8175	.8175	.821	.817
6.00	.8205	.8175	.817	.817	.8205	.8175	.817	.817	.821	.817
7.00	.8205	.8175	.817	.817	.8205	.8175	.817	.817	.8205	.817
8.00	.8205	.818	.817	.817	.8205	.8175	.817	.817	.8205	.817
9.00	.8205	.818	.8175	.8175	.8205	.8175	.817	.817	.8205	.817
10.00	.8205	.818	.8175	.8175	.8205	.8175	.817	.817	.8205	.817
15.00	.8205	.8185	.8175	.8175	.8205	.8175	.817	.817	.8205	.817
20.00	.8205	.8185	.8175	.8175	.8205	.8175	.817	.817	.8205	.817
25.00	.8205	.8185	.8175	.8175	.8205	.8175	.817	.817	.8205	.817
30.00	.8205	.819	.8195	.8195	.8205	.8195	.8195	.8195	.8205	.819
35.00	.8205	.8195	.8195	.8195	.8205	.8195	.8195	.8195	.8205	.819
40.00	.820	.819	.8185	.8185	.820	.819	.8185	.8185	.820	.819
45.00	.821	.820	.8195	.8195	.821	.820	.820	.820	.821	.820
46.00	.821	.820	.8195	.8195	.821	.820	.820	.820	.821	.820
47.00	.8205	.8195	.8195	.8195	.8205	.8195	.8195	.8195	.8205	.8195
48.00	.8205	.8195	.8195	.8195	.8205	.8195	.8195	.8195	.8205	.8195
49.00	.8205	.8195	.8195	.8195	.8205	.8195	.8195	.8195	.8205	.8195
50.00	.8205	.8195	.8195	.8195	.8205	.8195	.8195	.8195	.8205	.8195
51.00	.8195	.819	.8185	.8185	.8195	.819	.8185	.8185	.8195	.819
52.00	.819	.8195	.819	.819	.819	.819	.819	.819	.819	.819
52.25	.8195	.820	.819	.819	.820	.819	.819	.819	.820	.819

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NPG REPORT NO. 1342  
NAVORD REPORT NO. 1339

TABLE 13 CHAMBER MEASUREMENT DATA

Barrel No. EX-184, 20mm Mk 11 Mod 2

Distance from Breech Surface (ins.)	Drawing Dimensions	Chamber Diameter (ins.)			
		Prior to Firing	After Firing	After Firing	After Firing
			598 Rds.	1194 Rds.	2464 Rds.
359	1.1531+.002	1.1567	1.1570	1.1570	1.1570
1.209	1.1233+.002	1.1255	1.1256	1.1257	1.1258
1.739	1.1048+.002	1.1059	1.1060	1.1061	1.1062
2.239	1.0873+.002	1.0885	1.0887	1.0888	1.0888
2.739	1.0698+.002	1.0720	1.0722	1.0724	1.0724
3.039	1.0593+.002	1.0611	1.0613	1.0615	1.0615
Specs. 3.693+.005	.942	.9433	.9433	.9439	.9444
Actual 3.695		.942	.942	.9426	.9431
4.100	.834+.003	.847	.8468	.8470	.8472
4.200	.834+.003	.8437	.8428	.8422	.8421
4.300	.834+.003	.8431	.8414	.8410	.8403
4.330	.834+.003	.8439	.8413	.8415	.8411
4.370	.834+.003	.8448	.8426	.8428	.8416
4.380	.834+.003	.8448	.8423	.8428	.842
Specs. 4.458+.020	.828	.8403	.8377	.8374	.8363
4.523		.828	.8236	.8226	.8237
4.563		.821	.8188	.8172	.8169

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TABLE 14

TABULATED FIRING DATA

Date Fired: 29 May 1953

20mm Aircraft Gun Mk 12 Mod C Serial No. 500056

20mm Barrel Mk 11 Mod 2 Serial No. EX-183 Chrome Plated (No Previous Rounds)

Ammunition: Production Lot ZS-68-HMC-53 - Standard 20mm Mk 11 Mod 0 Target Projectiles

- 629 grains IMR 7013, Lot CDZA-1 Propellant Powder

Burst	Time	Belted	Fired	Rds. on Barrel	Cyclic Rate (rpm)	Average Velocity (ft./sec.)	Yaw (Degrees)				Dispersion		Remarks
							0-5	6-10	11-15	Over 15	100% Pattern		
							No. Rds.	No. Rds.	No. Rds.	No. Rds.	X	Y	
1	1118	50	50	50	974	3337±25	45	5			13.4	13.6	Stubbed round possibly due to defective end link.
2	1120	50	47	97	987	3362±24	41	6			10.6	11.5	
3	1122	50	50	147	985	3352±20	41	8	1		21.0	15.6	Failure to extract. Failure to extract. Failure to extract.
4	1124	50	4	151	--	--	2	2					
5	1126	45	4	155	--	--	3	1					Round in chamber but failed to fire.
6	1128	40	4	159	--	--	3	1					
7	1130	35	35	194	983	*3346±23	30	5			15.5	14.4	Failure to extract. Failure to extract.
8	1132	50	50	244	981	3329±15	28	18		1	20.3	14.3	
9	1134	50	50	294	971	3314±18	22	24	2	2	16.1	18.5	Failure to extract. Failure to extract.
10	1136	50	50	344	961	3290±14	24	21	5		17.3	17.5	
11	1138	50	50	394	955	3247±12	18	25	7		15.8	13.8	Round in chamber but failed to fire.
12	1140	50	50	444	947	3242±17	18	21	11		17.5	20.9	
13	1142	50	50	494	945	3224±14	26	15	9		18.1	16.9	Failure to extract. Failure to extract.
14	1144	49	49	543	938	3212±16	18	13	18		15.0	19.8	
15	1146	50	50	593	949	3210±17	18	24	7	1	21.1	16.3	Failure to extract. Failure to extract.
16	1148	50	34	627	938		16	13	5				
17	1150	14	14	641	933	**3211±23	7	6	1		18.9	16.1	Failure to extract. Failure to extract.
18	1152	40	40	681	923	3209±23	23	11	5	1	13.50	17.4	

\* Average of Bursts 4-7.

\*\* Average of Bursts 16-17.

CONFIDENTIAL

NPG REPORT NO. 1342  
NAVORD REPORT NO. 1339

TABLE 15

## TABULATED FIRING DATA

Date Fired: 24 September 1953  
 20mm Aircraft Gun Mk 12 Mod 0 Serial No. 501151  
 20mm Barrel Mk 11 Mod 2 Serial No. EX-183 Chrome Plated (681 Previous Rounds)  
 Ammunition: Production Lot ZS-69-HMC-53 - Standard 20mm Mk 11 Mod 0 Target Projectiles  
 - 629 grains IMR 7013, Lot CDZA-1 Propellant Powder

Burst	Time	Belted	Fired	Rds. on Barrel	Cyclic Rate (rpm)	Average Velocity (ft./sec.)	Yaw (Degrees)*						Dispersion 100% Pattern (ins.)		Remarks		
							0-5		6-10		11-15		Over 15			X	Y
							No.	Rds.	No.	Rds.	No.	Rds.	No.	Rds.			
1	1255	50	50	731	1028	3180	50					9.6	9.8	Broken end links.			
2	1257	50	49	780	1020	3167	39	9	1			11.7	14.4				
3	1301	50	50	830	1019	3158	34	13	2			12.3	13.1				
4	1304	50	2	832	--	--								Slow feed.			
4	1304	47	47	879	1010	3152	37	11	1			13.5	11.3				
5	1306	50	50	929	1005	Missed	22	19	8			15.6	15.2				
6	1307	50	50	979	989	3121	18	23	9			15.3	19.5	Slow feed.			
7	1310	50	43	1022			21	10	9			16.3	14.0				
7	1310	7	7	1029	995	3109	28	18	3			14.5	21.8				
8	1312	49	49	1078	986									End link jammed on stripper.			
9	1314	49	49	1127	982	3090	22	15	12			17.9	15.8				
10	1315	50	50	1177	972	3066	8	12	17			17.2	19.6				

\* Rounds omitted could not be measured.

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NPG REPORT NO. 1342  
NAVORD REPORT NO. 1339TABLE 16  
BARREL MEASUREMENT DATADate Fired: 29 May 1953  
Barrel No. EX-183, 20mm Mk 11 Mod 2 (No Previous Rounds)

Distance from Breech Surface (ins.)	Bore (0"787+0"002-0"000)				Diameters (ins.)				Grooves (0"817+0"004-0"000)			
	Prior Firing	After Firing	Prior to 681 Rds.	Prior Firing	After Firing	Prior to 681 Rds.	Prior Firing	After Firing	Prior to 681 Rds.	Prior Firing	After Firing	After Firing
4.69 Bore-4.63 0.788 Rifling		0.7875	0.7875	0.8295	0.788	0.820	0.820	0.831	0.820	0.831	0.8195	
5.0	0.787		0.787	0.809 )	0.7875	0.820	0.820	0.827	0.820	0.827	0.8195	
6.0	0.7875		0.787	0.794	0.7870	0.820	0.820	0.8155	0.820	0.8155	0.8195	
7.0	0.787		0.787	0.7965	0.7870	0.820	0.820	0.8165	0.8195	0.8165	0.8195	
8.0	0.787	0.793	0.787	0.7925	0.7870	0.820	0.820	0.8170	0.8195	0.8170	0.8195	0.817
9.0	0.787	0.792	0.787	0.792	0.7870	0.820	0.820	0.8175	0.8195	0.8175	0.8195	0.8175
10.0	0.7875	0.791	0.7875	0.7905	0.7870	0.820	0.820	0.8185	0.8195	0.8185	0.8195	0.818
15.0	0.787	0.7855	0.787	0.7855	0.7870	0.8195	0.8195	0.8180	0.8195	0.8180	0.8195	0.818
20.0	0.787	0.7865	0.787	0.786	0.7865	0.8195	0.8195	0.8185	0.8195	0.8185	0.819	0.8185
25.0	0.787	0.7885	0.7865	0.787	0.787	0.8195	0.8195	0.8185	0.8195	0.8180	0.819	0.8185
30.0	0.7865	0.788	0.787	0.7885	0.7865	0.8195	0.8195	0.8185	0.8195	0.8185	0.8195	0.8185
35.0	0.7865	0.7885	0.7865	0.788	0.7865	0.8195	0.8195	0.8185	0.8195	0.8185	0.8195	0.8185
40.0	0.786	0.788	0.7865	0.788	0.786	0.8195	0.8195	0.8185	0.819	0.8185	0.819	0.8185
45.0	0.786	0.789	0.7865	0.7885	0.786	0.819	0.819	0.8185	0.819	0.8185	0.819	0.819
46.0	0.786	0.789	0.786	0.789	0.786	0.819	0.819	0.8185	0.819	0.8185	0.819	0.819
47.0	0.786	0.789	0.786	0.7885	0.786	0.819	0.819	0.8185	0.819	0.8185	0.8185	0.819
48.0	0.7855	0.789	0.7855	0.789	0.7855	0.8185	0.8185	0.8185	0.8185	0.8185	0.8185	0.819
49.0	0.7855	0.789	0.7855	0.789	0.7855	0.8185	0.8185	0.8185	0.8185	0.8185	0.8185	0.819
50.0	0.7855	0.7885	0.7855	0.7885	0.7855	0.8185	0.8185	0.8185	0.8185	0.8185	0.8185	0.819
51.0	0.7855	0.7885	0.7855	0.788	0.7855	0.8185	0.8185	0.818	0.818	0.818	0.818	0.819
52.0	0.786	0.7895	0.7855	0.7895	0.7855	0.8185	0.8185	0.819	0.818	0.819	0.818	0.819
52.25	0.786	0.7895	0.786	0.7895	0.7865	--	--	--	--	--	--	--
52.40	--	--	--	--	--	0.820	0.8205	0.820	0.820	0.820	0.820	0.8205

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NPG REPORT NO. 1342  
NAVORD REPORT NO. 1339

TABLE 16 (Continued)

Barrel No. EX-183, 20mm Mk 11 Mod 2 (681 Previous Rounds)

Distance from Breech Surface (ins.)	Bore (0.787+0.002-0.000)				Diameters (ins.)				Grooves (0.817+0.004-0.000)			
	After Firing		Prior Firing		After Firing		Prior Firing		After Firing		Prior Firing	
	Prior to Firing Rds.	1177 to Firing Rds.	Prior to Firing Rds.	1177 to Firing Rds.	Prior to Firing Rds.	1177 to Firing Rds.	Prior to Firing Rds.	1177 to Firing Rds.	Prior to Firing Rds.	1177 to Firing Rds.	Prior to Firing Rds.	1177 to Firing Rds.
4.70			0.8295	0.839			0.817	0.815	0.8170	0.815	0.839	
5.00			--	0.837			0.8175	0.816	0.8175	0.816	0.839	
6.00			0.794	--			0.8185	--	--	--	--	
7.00			0.7965	--			0.8185	0.8165	0.8175	0.8165		
8.00	0.793		0.7925	0.803	0.7925		0.8185	0.8175	0.8180	0.8175	0.818	0.8175
9.00	0.792		0.792	--	0.792		0.8185	0.8175	0.8185	0.8175	0.818	0.8175
10.00	0.791	0.797	0.7915	0.796	0.7915	0.7965	0.8185	0.8165	0.8175	0.8165	0.818	0.8165
15.00	0.7855	0.790	0.7855	0.7915	0.7855	0.7905	0.8185	0.8175	0.8180	0.8175	0.818	0.8175
20.00	0.7865	0.787	0.786	0.788	0.786	0.7875	0.8185	0.817	0.8185	0.817	0.8185	0.8175
25.00	0.7885	0.787	0.787	0.7875	0.787	0.788	0.8185	0.8175	0.8180	0.8175	0.8185	0.8175
30.00	0.788	0.7885	0.787	0.788	0.787	0.788	0.8185	0.818	0.8185	0.818	0.8185	0.818
35.00	0.7885	0.789	0.7875	0.789	0.7875	0.7885	0.819	0.8185	0.8185	0.818	0.8185	0.8185
40.00	0.788	0.789	0.7875	0.789	0.7875	0.7885	0.8185	0.818	0.8185	0.818	0.8185	0.818
45.00	0.789	0.791	0.789	0.7905	0.789	0.789	0.819	0.8185	0.8185	0.819	0.819	0.8185
46.00	0.789	0.7905	0.7885	0.790	0.7885	0.790	0.819	0.8185	0.8185	0.819	0.819	0.8185
47.00	0.789	0.7905	0.7885	0.790	0.7885	0.790	0.8185	0.818	0.8185	0.818	0.819	0.8185
48.00	0.789	0.790	0.7885	0.790	0.7885	0.7895	0.8185	0.818	0.8185	0.818	0.819	0.818
49.00	0.789	0.790	0.789	0.790	0.789	0.790	0.8185	0.818	0.8185	0.818	0.819	0.818
50.00	0.7885	0.790	0.788	0.7895	0.788	0.7895	0.8185	0.818	0.8185	0.818	0.819	0.818
51.00	0.7885	0.7895	0.7875	0.789	0.7875	0.789	0.8185	0.818	0.8185	0.818	0.819	0.818
52.00	0.7895	0.791	0.7895	0.791	0.7895	0.791	0.819	0.8195	0.8195	0.819	0.8195	0.819
52.25	0.7895	0.791	0.7895	0.791	0.7895	0.791	0.8205	0.819	0.820	0.819	0.8205	0.819

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TABLE 17

## CHAMBER MEASUREMENT DATA

Barrel No. EX-183, 20mm Mk 11 Mod 2

Distance from Breech Surface (ins.)	Drawing Dimensions	Chamber Diameter (ins.)	
		Prior to Firing	After Firing 1177 Rds.
359	1.1531+.002	1.1548	1.1550
1.209	1.1233+.002	1.1248	1.1255
1.739	1.1048+.002	1.1044	1.1054
2.239	1.0873+.002	1.0871	1.0882
2.739	1.0698+.002	1.0708	1.0717
3.039	1.0593+.002	1.0608	1.0616
Specs. 3.693+.005	.942	.9453	.9457
3.6975		.942	.9424
4.100	.834+.003	.8431	.8433
4.200	.834+.003	.8414	.8397
4.300	.834+.003	.8406	.8375
4.320	.834+.003	.8401	.8375
4.360	.834+.003	.8432	.8405
4.370	.834+.003	.8432	.8404
Specs. 4.458+.020	.828	.8346	.8315
4.489		.828	.8285
4.530		.821	.8327

Note: Barrel Chamber Surface Finish Prior to Firing 6-21 Microinches.

 NPG REPORT NO. 1342  
 NAVORD REPORT NO. 1339



TABLE 18

## TABULATED FIRING DATA

Date Fired: 3 February 1954  
 20mm Aircraft Gun Mk 12 Mod 0 Serial No. 500243  
 20mm Barrel Mk 11 Mod 2 Serial No. EX-182 Chrome Plated (5 Previous Rounds)  
 Ammunition: Production Lot ZS-69-HMC-53 - Standard 20mm Mk 11 Mod 0 Target Projectiles  
 - 629 grains IMR 7013, Lot CDZA-1 Propellant Powder

Burst	Time	Belted	Fired	Rds. on Barrel	Cyclic Rate (rpm)	Average Velocity (ft./sec.)	Yaw Degrees)*						Over 15 No. Rds.	Dispersion 100% Pattern (ins.)	
							0-5	6-10	11-15	X	Y				
							No. Rds.	No. Rds.	No. Rds.						
1	0955	10	10	15	918	3332±36	10							9.9	8.1
2	1038	50	50	65	985	3351±31	21	9	2					11.4	16.7
3	1041	50	50	115	992	3387±24	14	9	11					17.5	19.1
4	1043	50	50	165	996	3381±27	14	7	18					18.7	17.4
5	1045	50	50	215	983	3352±28	14	11	12					12.7	14.3
6	1047	50	50	265	1006	3356±19	18	7	13					15.7	15.4
7	1049	50	50	315	993	3327±15	22	9	6					17.2	13.0
8	1051	50	50	365	970	3269±12	19	13	13					18.9	15.4
9	1053	50	50	415	958	3236±15	18	11	16					13.9	16.8
10	1055	50	50	465	952	3218±18	13	13	20					15.6	14.8
11	1057	50	50	515	947	3225±16	11	14	19					16.2	17.4
12	1100	50	50	565	939	3190±21	13	7	10					16.4	14.3
13	1102	50	50	615	936	3177±22	4	5	10						
		**10	10	625	931	3204±26									

\* Rounds omitted could not be measured.

\*\* Gun at Ambient Temperature.

TABLE 19

## TABULATED FIRING DATA

Date Fired: 12 February 1954  
 20mm Aircraft Gun Mk 12 Mod 0 Serial No. 500243  
 20mm Barrel Mk 11 Mod 2 Serial No. EX-182 Chrome Plated (625 Previous Rounds)  
 Ammunition: Production Lot ZS-69-HMC-53 - Standard 20mm Mk 11 Mod C Target Projectiles  
 - 629 grains IMR 7013, Lot CDZA-1 Propellant Powder

Burst	Time	Belted	Fired	Rds. on Barrel	Cyclic Rate (rpm)	Average Velocity (ft./sec.)	Yaw (Degrees)*						Over 15 No. Rds.	Dispersion 100% Pattern (ins.)	
							0-5	6-10	11-15	No. Rds.	No. Rds.	No. Rds.		X	Y
							No. Rds.	No. Rds.	No. Rds.						
1	1107	10	10	635	918	3096±13	29	18	1			--	--	9.5	10.7
2	1109	50	50	685	971	3106±17	21	15	8	1			10.1	11.3	
3	1111	50	50	735	970	3122±18	23	12	11				13.5	11.7	
4	1113	50	50	785	977	3139±21	15	7	3				--	--	
5	1115	50	29	814	965	3122±24	12	6	2				10.6	13.7	
6	1116	22	21	835	968	3104±21	29	9	8				14.3	14.3	
7	1118	50	50	885	957	3107±21	18	8	11	4			18.4	16.6	
8	1120	50	50	935	957	3090±23	17	11	13	7			14.6	14.6	
9	1122	50	50	985	952	3090±20	23	11	11	5			13.7	14.6	
10	1124	50	49	1034	945	3093±23	17	11	11	13			16.2	19.9	
11	1126	50	50	1084	936	3087±29	17	12	7						
		**10	10	1094	926	3039±15									

Notes: Gun stoppage on Burst 5 due to bolt stopping 1"5 out of battery.

\* Rounds omitted could not be measured.

\*\* Gun at Ambient Temperature.

TABLE 20  
BARREL MEASUREMENT DATA

Barrel No. EX-182, 20mm Mk 11 Mod 2

Distance from Breech Surface (ins.)	Bore (0.7874-0.002-0.000)				Diameters (ins.)				Grooves (0.8174-0.004-0.000)			
	Prior Firing	After Firing	Prior Firing	After Firing	Prior Firing	After Firing	Prior Firing	After Firing	Prior Firing	After Firing	Prior Firing	After Firing
	to 625 Rds.	to 1095 Rds.	to 625 Rds.	to 1095 Rds.	to 625 Rds.	to 1095 Rds.	to 625 Rds.	to 1095 Rds.	to 625 Rds.	to 1095 Rds.	to 625 Rds.	to 1095 Rds.
4.69	.7875	Note 1	.7880	Note 1	.7880	Note 1	.7880	Note 1	.8195	Note 2	.8195	Note 3
5.00	.7870	Note 1	.7875	Note 1	.7885	Note 1	.7885	Note 1	.8195	Note 2	.8195	Note 3
6.00	.7870	Note 1	.7870	Note 1	.7880	Note 1	.7880	Note 1	.8195	Note 2	.8195	Note 3
7.00	.7870	Note 1	.7870	Note 1	.7880	Note 1	.7880	Note 1	.8195	Note 2	.8195	Note 3
8.00	.7875	.7955	.7875	.7920	.7875	.7965	.7875	.7965	.8195	.8160	.8190	.8160
9.00	.7875	.7955	.7875	.7920	.7875	.7965	.7875	.7965	.8195	.8160	.8190	.8160
10.00	.7870	.7875	.7870	.7875	.7870	.7875	.7870	.7875	.8195	.8170	.8195	.8170
15.00	.7870	.7875	.7870	.7875	.7870	.7875	.7870	.7875	.8195	.8170	.8195	.8170
20.00	.7865	.7865	.7865	.7865	.7865	.7865	.7865	.7865	.8195	.8175	.8195	.8175
25.00	.7865	.7865	.7865	.7865	.7865	.7865	.7865	.7865	.8195	.8175	.8195	.8175
30.00	.7865	.7865	.7865	.7865	.7865	.7865	.7865	.7865	.8195	.8175	.8195	.8175
35.00	.7865	.7865	.7865	.7865	.7865	.7865	.7865	.7865	.8195	.8175	.8195	.8175
40.00	.7865	.7865	.7865	.7865	.7865	.7865	.7865	.7865	.8195	.8175	.8195	.8175
45.00	.7865	.7865	.7865	.7865	.7865	.7865	.7865	.7865	.8195	.8175	.8195	.8175
46.00	.7865	.7865	.7865	.7865	.7865	.7865	.7865	.7865	.8195	.8175	.8195	.8175
47.00	.7865	.7865	.7865	.7865	.7865	.7865	.7865	.7865	.8195	.8175	.8195	.8175
48.00	.7865	.7865	.7865	.7865	.7865	.7865	.7865	.7865	.8195	.8175	.8195	.8175
49.00	.7865	.7865	.7865	.7865	.7865	.7865	.7865	.7865	.8195	.8175	.8195	.8175
50.00	.7865	.7865	.7865	.7865	.7865	.7865	.7865	.7865	.8195	.8175	.8195	.8175
51.00	.7865	.7865	.7865	.7865	.7865	.7865	.7865	.7865	.8195	.8175	.8195	.8175
52.00	.7865	.7865	.7865	.7865	.7865	.7865	.7865	.7865	.8195	.8175	.8195	.8175
52.25	.7865	.7865	.7865	.7865	.7865	.7865	.7865	.7865	.8195	.8175	.8195	.8175
52.40	.7870	--	.7870	--	.7870	--	.7870	--	.8210	.8215	.8210	.8215

Note 1: Unable to gauge lands - Nons at that point; worn off to .832 - .836 Dia. after 625 rds. and .836 - .841 Dia. after 1095 rds.

Note 2: Gauging Distance

- 4.63 Diameter from .834 to .835
- 4.69 Diameter from .832 to .836 (Origin of Bore)
- 5.00 Diameter from .8195 to .8335

Note 3: 4.63 Diameter from .8385 to .840  
4.69 Diameter from .838 to .841 (Origin of Bore)  
5.00 Diameter from .8315 to .8385  
6.00 Diameter from .811 to .824

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NPG REPORT NO. 1342  
NAVORD REPORT NO. 1339

TABLE 21  
CHAMBER MEASUREMENT DATA

Barrel No. EX-182, 20mm Mk 11 Mod 2

Distance from Breach Surface (ins.)	Drawing Dimensions	Chamber Diameter (ins.)	
		Prior to Firing	After Firing 625 Rds.
.359	1.1531+.002	1.1537	1.1540
1.209	1.1233+.002	1.1233	1.1236
1.739	1.1048+.002	1.1041	1.1046
2.239	1.0873+.002	1.0865	1.0872
2.739	1.0698+.002	1.0704	1.0710
3.039	1.0593+.002	1.0598	1.0603
Specs. 3.693+.005	.942	.9464	.9471
3.6991		.9420	.9426
4.100	.834+.003	.8414	.8413
4.200	.834+.003	.8411	.8402
4.300	.834+.003	.8409	.8379
4.320	.834+.003	.8399	.8364
4.330	.834+.003	.8399	.8369
4.370	.834+.003	.8420	.8381
4.380	.834+.003	.8420	.8381
Specs. 4.458+.020	.828	.8342	.8318
4.489		.8280	.8286
4.531		.8210	.8335

See Note 1

See Note 2

See Note 2

Note 1: Circumferential Tool Marks 3"12 From Breech Face, Body of Chamber Pitted, Small Pitts in Shoulder and Neck Area.

Note 2: Some accumulation of Matter in Rifling, causing an irregular finish appearance, also some build up of substance in the Neck Area of Chamber having a Carbonized appearance. Small section of one land torn away approximately 23"37 from breech face.

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NPG REPORT NO. 1342  
NAWORD REPORT NO. 1339TABLE 22  
TABULATED FIRING DATA

Date Fired: 10 September 1954  
 20mm Aircraft Gun Mk 12 Mod 0 Serial No. 506103  
 20mm Barrel Mk 11 Mod 2 Serial No. 855108 Chrome Plated (5 Previous Rounds)  
 Projectiles: Type 2 Mod 2 (Nylon Bands Lot SLOW)  
 Propellant: 630 grains IFR 7013, Lot 1A-4C302 Powder

Burst	Time	Belted	Fired	Rds. on Barrel	Cyclic Rate (rpm)	Average Velocity (ft./sec.)	Yaw (Degrees)*						Dispersion 100% Pattern (ins.)		Remarks		
							0-5		6-10		11-15		Over 15			X	Y
							No.	Rds.	No.	Rds.	No.	Rds.	No.	Rds.			
1	1120	13	13	18	957	3323±10	13								Yaw machine stopped therefore very few individual yaws were obtained.		
2	1307	50	50	68	963	3321±13	16										
3	1309	50	50	118	984	3315±17	48	1	1			13.8	12.C				
4	1311	50	50	168	1007	3301±22	43	5	2			12.6	14.2				
5	1313	50	50	218	1011	3298±22	41	4	4		1	19.6	16.0				
6	1315	50	50	268	997	3289±23	40	5	2		3	20.1	13.6				
7	1317	50	50	318	995	3284±24	27	13	5		3	20.4	15.4				
8	1319	50	50	368	996	3287±29	34	6	8		2	18.0	21.5				
9	1321	50	50	418	991	3271±19	39	3	7		2	22.7	16.7				
10	1323	50	50	468	976	3288±16	33	7	6		3	20.4	21.2				
11	1325	50	50	518	960	3272±17	36	4	6		2	20.5	17.4				
12	1327	50	50	568	956	3289±19	37	4	3		3	19.6	18.6				
13	1329	50	50	618	946	3280±20	34	8	5		3	18.6	22.3				
		**12	12	630	938	3318±9	12										

\* Rounds omitted could not be measured.  
 \*\* Gun at Ambient Temperature.

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NPG REPORT NO. 1342  
NAVORD REPORT NO. 1339

TABLE 23  
BARREL MEASUREMENT DATA

20mm Barrel Mk II Mod 2 Serial No. 855108 Chrome Plated

Distance from Breech Surface (ins.)	Bore (C <sup>787</sup> +0 <sup>002</sup> -0 <sup>000</sup> )				Grooves (G <sup>817</sup> +0 <sup>004</sup> -0 <sup>000</sup> )			
	After Firing		Prior Firing		After Firing		Prior Firing	
	Prior to Firing	630 Rds.	Prior to Firing	630 Rds.	Prior to Firing	630 Rds.	Prior to Firing	630 Rds.
4.75	.789	.7875	.789	.7875	.820	.8155	.820	.8155
5.00	.789	.7865	.789	.787	.820	.8155	.820	.816
6.00	.789	.7855	.789	.786	.8205	.816	.820	.816
7.00	.789	.785	.789	.7855	.820	.816	.820	.8165
8.00	.7885	.7855	.7885	.785	.820	.816	.820	.8165
9.00	.7885	.786	.7885	.786	.820	.816	.820	.816
10.00	.7885	.786	.7885	.7855	.820	.8165	.820	.8165
15.00	.7885	.7865	.7885	.786	.820	.817	.8205	.817
20.00	.7885	.787	.7885	.7865	.8205	.8175	.8205	.818
25.00	.7885	.788	.7885	.788	.8205	.818	.8205	.8185
30.00	.7885	.788	.7885	.788	.8205	.8185	.8205	.819
35.00	.789	.7885	.7885	.7885	.821	.819	.8205	.8195
40.00	.789	.789	.789	.7895	.821	.8195	.821	.8195
45.00	.789	.7895	.789	.790	.821	.8195	.821	.820
46.00	.789	.7895	.789	.7895	.821	.8195	.821	.820
47.00	.789	.7895	.789	.7895	.821	.820	.821	.820
48.00	.789	.790	.789	.790	.821	.820	.821	.820
49.00	.789	.790	.789	.790	.821	.820	.821	.820
50.00	.789	.7895	.789	.7895	.821	.8205	.821	.820
51.00	.789	.7895	.789	.7895	.821	.8205	.821	.820
52.00	.7895	.7895	.7895	.7915	.8215	.822	.8215	.821

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NPG REPORT NO. 1342  
NAVORD REPORT NO. 1339

TABLE 24  
CHAMBER MEASUREMENT DATA

Barrel No. 855108, 20mm Mk 11 Mod 2

Distance from Breech Surface (ins.)	Chamber Diameter (ins.)		After Firing 630 Rds.
	Drawing Dimensions	Prior to Firing	
.359	1.1531+.002	1.1593	1.1595
1.209	1.1233+.002	1.1287	1.1288
1.739	1.1048+.002	1.1104	1.1105
2.239	1.0873+.002	1.0928	1.0929
2.734	1.0698+.002	1.0749	1.0750
3.039	1.0593+.002	1.0643	1.0645
Specs. 3.693+.005	.942	.9406	.9405
Actual 3.691		.942	.9418
4.100	.834+.003	.8364	.8361
4.200	.834+.003	.8364	.8361
4.300	.834+.003	.8364	.8334
4.400	.834+.003	.8315	.8313
Specs. 4.458+.020	.828	.828	.8262
Actual 4.4751			.8229

Note: Post Firing Inspection: There is an irregular build up of matter on the rifling and in the neck area of chamber near the origin of rifling. The build up on the rifling is greater near the origin of rifling and gradually diminishes in quantity toward the muzzle.

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TABLE 25

## TABULATED FIRING DATA

Date Fired: 4 June 1954  
 20mm Aircraft Gun Mk 12 Mod 0 Serial No. 500614  
 20mm Barrel Mk 11 Mod 2 Serial No. 854254 Chrome Plated (5 Previous Rounds)  
 Projectiles: Type 2 Mod 2 (Nylon Bands Lot S9)  
 Propellant: 62C grains IMR 7013, Lot 1A-40302 Powder

Burst	Time	Belted	Fired	Rds. on Barrel	Cyclic Rate (rpm)	Average Velocity (ft./sec.)	Yaw (Degrees)				Dispersion		Remarks
							0-5	6-10	11-15	Over 15	100% Pattern		
							No.	No.	No.	No.	(ins.)		
				Rds.	Rds.	Rds.	Rds.	X	Y				
1	1333	15	15	20	1005	3249±15	15				8.2	9.0	Slow feeder.
2	1341	50	50	70	1027	3271±13	50						
3	1343	50	3	73		3246±18	3						Slow feeder.
4	1344	46	46	119	1023	3256±18	44	2			15.6	11.6	
5	1346	50	2	121			2						Failed to extract.
6	1347	49	17	138	1005	3256±14	17				13.7	10.1	
7	1349	31	29	167	1000	3254±15	28						Slow feeder.
8	1351	50	50	217	1004	3246±12	43	6	1	1	13.3	13.9	
9	1353	50	15	232		3246±16	13	1	1				Slow feeder.
10	1355	33	33	265	992	3238±16	22	7	4		18.6	16.6	
11	1357	50	9	274		3209±34	7	2					Failed to extract.
12	1359	40	40	314	990	3251±16	36	2	1	1	14.7	18.6	
13	1400	50	48	362	982	3248±13	34	9	4	1	19.6	19.0	Slight pause during burst.
14	1402	50	17	379		3237±14	13	3		1			Ammunition chute broken.
15	1406	33	20	399		3235±14	12	7		1			Bolt out of battery.
16	1409	13	1	400			1						Bolt out of battery.
17	1410	12	3	403		321C±43	3			1	17.6	16.1	Bolt out of battery.
18*	1411	9	4	407		3221±37	3						Gun failed to extract.
													expended case. Also had a broken lock and bad extractor spring.

\* The test was halted at this point because of the numerous gun stoppages.



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NPG REPORT NO. 1342  
NAVORD REPORT NO. 1339

TABLE 26  
BARREL MEASUREMENT DATA

20mm Barrel Mk II Mod 2 Serial No. 854254 Chrome Plated

Distance from Breech Surface (ins.)	Bore (C".787+C".002-C".000)						Grooves (C".817+C".004-C".000)					
	After Firing		Prior Firing		After Firing		After Firing		Prior Firing		After Firing	
	Prior to Firing	Rds.	Prior to Firing	Rds.	Prior to Firing	Rds.	Prior to Firing	Rds.	Prior to Firing	Rds.	Prior to Firing	Rds.
4.75	.790	.790	.790	.7905	.789	.789	.822	.819	.822	.819	.822	.819
5.00	.790	.7885	.790	.790	.7885	.7885	.822	.8195	.822	.819	.822	.819
6.00	.790	.788	.790	.790	.7885	.788	.822	.819	.822	.820	.822	.820
7.00	.790	.788	.790	.790	.7885	.788	.822	.819	.822	.8195	.822	.8195
8.00	.790	.788	.790	.790	.7885	.788	.822	.819	.822	.8195	.822	.8195
9.00	.7895	.788	.7895	.7895	.788	.788	.822	.8195	.822	.819	.822	.820
10.00	.7895	.788	.7895	.7895	.788	.788	.822	.820	.822	.8195	.822	.8195
15.00	.789	.788	.789	.789	.788	.788	.8215	.819	.8215	.819	.8215	.819
20.00	.789	.788	.789	.789	.788	.788	.8215	.820	.8215	.820	.8215	.820
25.00	.7885	.788	.7885	.7885	.788	.788	.821	.820	.821	.820	.821	.820
30.00	.788	.788	.7885	.788	.788	.788	.821	.820	.821	.8195	.821	.8195
35.00	.788	.788	.788	.788	.788	.788	.8205	.820	.8205	.8195	.8205	.8195
40.00	.7875	.788	.7875	.7875	.788	.788	.8205	.819	.8205	.8195	.8205	.8205
45.00	.7875	.7885	.7875	.7875	.788	.788	.8205	.820	.8205	.820	.8205	.8205
46.00	.7875	.7885	.7875	.7875	.788	.788	.8205	.820	.8205	.820	.8205	.820
47.00	.7875	.788	.7875	.7875	.788	.788	.8205	.8205	.8205	.820	.8205	.820
48.00	.7875	.788	.7875	.7875	.7885	.7885	.8205	.8205	.8205	.820	.8205	.820
49.00	.7875	.7875	.7875	.7875	.787	.787	.8205	.8205	.8205	.820	.8205	.820
51.00	.7875	.788	.7875	.7875	.7875	.7875	.8205	.820	.8205	.820	.8205	.820
52.00	.7875	.7885	.7875	.7875	.788	.788	.8205	.820	.8205	.8205	.8205	.8205

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CHAMBER MEASUREMENT DATA

TABLE 27

Barrel No. 854254, 20mm Mk 11 Mod 2

Distance from Breech Surface (ins.)	Drawing Dimensions	Chamber Diameter (ins.)	
		Prior to Firing	After Firing 407 Rds.
.359	1.1531+.002	1.1588	1.1589
1.209	1.1233+.002	1.1286	1.1286
1.739	1.1048+.002	1.1096	1.1077
2.239	1.0873+.002	1.0918	1.0919
2.739	1.0698+.002	1.0744	1.0745
3.039	1.0593+.002	1.0642	1.0642
Specs. 3.693+.005	.942	.9386	.9386
Actual 3.6885		.942	.942
4.100	.834+.003	.8385	.8384
4.200	.834+.003	.8383	.8378
4.300	.834+.003	.8383	.8364
Specs. 4.458+.020	.828	.8321	.8287
Actual 4.4771		.828	.8236

Notes: R.M.S. value of chamber surface finish in microinches - chamber to front slope 8 to 21, chamber neck area 12-14. Front slope pitted, pits scattered around chamber body, non-concentric ring or raised surface around front slope chamber not within tolerances.

After firing there is a build up of matter on lands and grooves forming a rough crackle type finish similar to barrel EX-184. Fine heat cracks at origin of lands.

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APPENDIX G

TABLE 28  
TABULATED FIRING DATA

Date Fired: 11 September 1953  
20mm Aircraft Gun Mk 12 Mod C Serial No. 501151  
20mm Barrel Mk 11 Mod 2 Serial No. 854342 Unplated (5 Previous Rounds)  
Projectiles: Type 2 Mod 2 (Nylon Bands Lot S2B)  
Propellant: 620 grains IMR 7013, Lot 1A-40302 Powder

Burst	Time	Beltd	Fired	Rds. on Barrel	Cyclic Rate (rpm)	Average Velocity (ft./sec.)	Yaw (Degrees)*				Dispersion 100% Pattern (ins.)		Remarks
							0-5	6-10	11-15	Over 15			
							Rds.	Rds.	Rds.	Rds.	X	Y	
1	1406	50	48	53	976	3336±13	42	6			11.5	8.5	Ammunition belt separation.
2	1408	50	50	103	996	3337±7	44	6			12.5	13.0	
3	1410	50	50	153	1021	3335±9	39	6	2	1	14.0	15.5	
4	1412	48	48	201	1028	3323±16	38	7		1	16.0	15.0	
5	1414	50	50	251	1024	3318±9	39	7	3	1	18.0	20.5	
6	1416	50	50	301	1010	3314±9	36	9	4	1	17.5	15.0	
7	1419	50	50	351	1007	3318±9	39	9	1	1	17.0	16.5	
8	1421	50	50	401	1001	3305±10	34	5	7	4	22.0	15.5	Broken feeder anchor arms.
9	1424	53	31	432	989	3290±10	16	5	7	2			
	1429	22	22	454	991	3298±9	19	2		1	19.0	22.0	
10	1431	50	50	504	997	3295±10	30	15	4	1	17.0	17.0	
11	1433	50	48	552	987	3282±14	42	3	2	1	19.5	20.5	Defective end link.
12	1435	52	52	604	991	3260±11	28	4	6	14	21.5	23.0	

\* Rounds omitted could not be measured.

TABLE 29

TABULATED FIRING DATA

Date Fired: 20 May 1954  
 20mm Aircraft Gun Mk 12 Mod 0 Serial No. 501614  
 20mm Barrel Mk 11 Mod 2 Serial No. 854342 Unplated (604 Previous Rounds)  
 Projectiles: Type 2 Mod 2 (Nylon Bands Lot S9)  
 Propellant: 620 grains IMR 7013, Lot LA-40302 Powder

Burst	Time	Belted	Fired	Rds. on Barrel	Cyclic Rate (rpm)	Average Velocity (ft./sec.)	Yaw (Degrees)*				Over No. Rds.	Dispersion 100% Pattern (ins.)	
							0-5	6-10	11-15	15		X	Y
							No. Rds.	No. Rds.	No. Rds.	No. Rds.			
1	1420	15	15	619	1040	3233±8	15					11.0	7.8
2	1431	50	50	669	1059	3232±7	44	6				13.0	10.8
3	1433	50	50	719	1059	3227±12	42	6	2	2		13.1	13.1
4	1435	50	50	769	1057	3222±11	38	6	4	1		15.1	11.8
5	1442	50	50	819	1029	3219±13	41	4	4	3		12.6	12.4
6	1445	50	50	869	989	3210±14	41	3	3	9		18.9	19.3
7	1447	50	42	911	1013	3198±14	14	2	12	17		24.0	22.4
8	1449	50	50	961	991	3176±18	20	4	5	24		23.3	21.3
9	1451	50	50	1011	996	3158±20	12	7	8				
		**15	15	1026		3204±15							
21 May		**15	15	1041		3201±10	7	2	6				

\* Rounds omitted could not be measured.

\*\* Gun at Ambient Temperature.

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NPG REPORT NO. 1342  
NAVORD REPORT NO. 1339TABLE 30  
BARREL MEASUREMENT DATA

20mm Barrel Mk 11 Mod 2 Serial No. 854342 Unplated

Distance from Muzzle Surface (ins.)	Bore (0787-0F002-09000)										Grooves (0817-0F004-09000)									
	After Firing		Prior Firing		After Firing		Prior Firing		After Firing		After Firing		Prior Firing		After Firing		Prior Firing		After Firing	
	604 Rds.	1041 Rds.	604 Rds.	1041 Rds.	604 Rds.	1041 Rds.	604 Rds.	1041 Rds.	604 Rds.	1041 Rds.	604 Rds.	1041 Rds.	604 Rds.	1041 Rds.	604 Rds.	1041 Rds.	604 Rds.	1041 Rds.	604 Rds.	1041 Rds.
0.00	.788	.789	.7875	.789	.7875	.789	.7875	.789	.7875	.789	.7875	.789	.7875	.789	.7875	.789	.7875	.789	.7875	.789
1.00	.788	.7885	.788	.7885	.788	.7885	.788	.7885	.788	.7885	.788	.7885	.788	.7885	.788	.7885	.788	.7885	.788	.7885
2.00	.788	.788	.7875	.788	.7875	.788	.7875	.788	.7875	.788	.7875	.788	.7875	.788	.7875	.788	.7875	.788	.7875	.788
3.00	.788	.788	.7875	.788	.7875	.788	.7875	.788	.7875	.788	.7875	.788	.7875	.788	.7875	.788	.7875	.788	.7875	.788
4.00	.788	.788	.7875	.788	.7875	.788	.7875	.788	.7875	.788	.7875	.788	.7875	.788	.7875	.788	.7875	.788	.7875	.788
8.00	.7875	.788	.7875	.788	.7875	.788	.7875	.788	.7875	.788	.7875	.788	.7875	.788	.7875	.788	.7875	.788	.7875	.788
12.00	.788	.7875	.7875	.788	.7875	.788	.7875	.788	.7875	.788	.7875	.788	.7875	.788	.7875	.788	.7875	.788	.7875	.788
16.00	.788	.7875	.7875	.788	.7875	.788	.7875	.788	.7875	.788	.7875	.788	.7875	.788	.7875	.788	.7875	.788	.7875	.788
20.00	.788	.787	.7875	.787	.7875	.787	.7875	.787	.7875	.787	.7875	.787	.7875	.787	.7875	.787	.7875	.787	.7875	.787
22.00	.788	.787	.7875	.787	.7875	.787	.7875	.787	.7875	.787	.7875	.787	.7875	.787	.7875	.787	.7875	.787	.7875	.787
24.00	.788	.787	.7875	.787	.7875	.787	.7875	.787	.7875	.787	.7875	.787	.7875	.787	.7875	.787	.7875	.787	.7875	.787
26.00	.788	.787	.7875	.787	.7875	.787	.7875	.787	.7875	.787	.7875	.787	.7875	.787	.7875	.787	.7875	.787	.7875	.787
28.00	.788	.787	.7875	.787	.7875	.787	.7875	.787	.7875	.787	.7875	.787	.7875	.787	.7875	.787	.7875	.787	.7875	.787
30.00	.788	.7865	.788	.7865	.788	.7865	.788	.7865	.788	.7865	.788	.7865	.788	.7865	.788	.7865	.788	.7865	.788	.7865
32.00	.788	.7865	.788	.7865	.788	.7865	.788	.7865	.788	.7865	.788	.7865	.788	.7865	.788	.7865	.788	.7865	.788	.7865
34.00	.788	.7865	.788	.7865	.788	.7865	.788	.7865	.788	.7865	.788	.7865	.788	.7865	.788	.7865	.788	.7865	.788	.7865
36.00	.788	.7865	.788	.7865	.788	.7865	.788	.7865	.788	.7865	.788	.7865	.788	.7865	.788	.7865	.788	.7865	.788	.7865
38.00	.788	.7865	.788	.7865	.788	.7865	.788	.7865	.788	.7865	.788	.7865	.788	.7865	.788	.7865	.788	.7865	.788	.7865
40.00	.788	.787	.788	.787	.788	.787	.788	.787	.788	.787	.788	.787	.788	.787	.788	.787	.788	.787	.788	.787
42.00	.788	.787	.788	.787	.788	.787	.788	.787	.788	.787	.788	.787	.788	.787	.788	.787	.788	.787	.788	.787
44.00	.788	.7875	.788	.7875	.788	.7875	.788	.7875	.788	.7875	.788	.7875	.788	.7875	.788	.7875	.788	.7875	.788	.7875
46.00	.7885	.7905	.7885	.7905	.7885	.7905	.7885	.7905	.7885	.7905	.7885	.7905	.7885	.7905	.7885	.7905	.7885	.7905	.7885	.7905
47.00	.7885	.7935	.7885	.7935	.7885	.7935	.7885	.7935	.7885	.7935	.7885	.7935	.7885	.7935	.7885	.7935	.7885	.7935	.7885	.7935
47.50	.7885	.795	.7885	.795	.7885	.795	.7885	.795	.7885	.795	.7885	.795	.7885	.795	.7885	.795	.7885	.795	.7885	.795
		to		to		to		to		to		to		to		to		to		to
	.789	.800	.789	.800	.789	.800	.789	.800	.789	.800	.789	.800	.789	.800	.789	.800	.789	.800	.789	.800
47.75		to		to		to		to		to		to		to		to		to		to
	.8005	.8005	.8005	.8005	.8005	.8005	.8005	.8005	.8005	.8005	.8005	.8005	.8005	.8005	.8005	.8005	.8005	.8005	.8005	.8005
47.81	.790	.8035	.790	.8035	.790	.8035	.790	.8035	.790	.8035	.790	.8035	.790	.8035	.790	.8035	.790	.8035	.790	.8035
		to		to		to		to		to		to		to		to		to		to
		.804		.804		.804		.804		.804		.804		.804		.804		.804		.804

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NPG REPORT NO. 1342  
NAVORD REPORT NO. 1339

TABLE 31 CHAMBER MEASUREMENT DATA

Barrel No. 854342, 20mm Mk 11 Mod 2

Distance from Breach Surface (ins.)	Drawing Dimensions	Chamber Diameters (ins.)		
		Prior to Firing	After Firing 604 Rds.	After Firing 1041 Rds.
.359	1.1531+.002	1.1535	1.1536	1.537
1.209	1.1233+.002	1.1240	1.1241	1.1242
1.739	1.1048+.002	1.1053	1.1054	1.1056
2.239	1.0873+.002	1.0877	1.0879	1.0878
2.739	1.0698+.002	1.0703	1.0705	1.0706
3.039	1.0593+.002	1.0598	1.0600	1.0606
Specs. 3.693+.005	.942	.9418	.9425	.9427
Actual 3.698				
4.100	.834+.003	.8365	.8364	.8366
4.150	.834+.003	.8365	.8364	
4.200	.834+.003	.8364	.8351	.8355
4.250	.834+.003	.8364	.8353	
4.300	.834+.003	.8363	.8369	.8390
4.350	.834+.003	.8360	.8333	.8345
4.400	.834+.003	.8352	.8324	.8328
Specs. 4.458+.020	.828	.8293	.8300	.8319
4.478		.8252	.8268	.8305
4.500		.8209	.8236	.8264
4.515		.8180	.8214	.824

Note: Driving edge of lands noticeably worn after 1041 rounds for approximately 9" from origin, severe in intensity at origin and gradually diminishing toward muzzle, severe erosion at gas port, heat check marks in rifling varying from severe in intensity at approximately 2" from origin and diminishing to mild intensity 16" from origin.

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TABLE 32

TABULATED FIRING DATA

Date Fired: 9 November 1953  
 20mm Aircraft Gun Mk 12 Mod 0 Serial No. 500899  
 20mm Barrel Mk 11 Mod 2 Serial No. 856686 Unplated (5 Previous Rounds)  
 Ammunition: Local Assembly - Standard 20mm Mk 11 Mod 0 Target Projectiles  
 - 633 grains IMR 7CL3, Lot 1A-40302 Propellant Powder

Burst	Time	Belted	Fired	Rds. on Barrel	Cyclic Rate (rpm)	Average Velocity (ft./sec.)	Yaw (Degrees)*				Remarks
							0-5	6-10	11-15	16-20	
							No.	No.	No.	No.	
							Rds.	Rds.	Rds.	Rds.	Dispersion 100% Pattern (ins.)
											X    Y
1	1536	50	50	55	975	3331	32	18	--	--	7.9   9.6
2	1530	51	51	106	960	3304	33	17	--	--	12.5   10.2
3	1540	49	49	155	992	3299	28	19	2	--	15.8   10.0
4	1542	50	39	194	950		21	10	6	2	
4	1543	11	11	205	893	3248	1	5	4	--	14.5   17.5
5	1545	50	50	255	976	3238	21	18	9	1	14.7   16.3
6	1548	50	50	305	1019	3198	22	20	4	4	17.8   13.2
7	1550	50	50	355	1004	3176	21	18	11	--	14.7   16.4
8	1552	50	31	386	1001		12	5	7	7	
8	1554	18	18	404	1002	3168	1	5	10	2	20.3   19.5
9	1555	50	50	454	1008	3171	23	12	14	1	18.0   11.9
10	1557	50	30	484	986		6	14	8	2	
10	1558	19	19	503	975	3107	8	9	2	--	Broken feeder anchor arm.
11	1600	50	15	518	--	3122	10	4	1	--	16.3   16.5

Test discontinued due to broken feed mechanism.

\* Rounds omitted could not be measured.



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TABLE 33  
BARREL MEASUREMENT DATA

Barrel No. 856686, 20mm Mk 11 Mod 2 (5 Previous Rounds)

Distance from Breech Surface (ins.)	Bore (0"787+0"002-0"000)						Grooves (0"817+0"004-0"000)					
	After Firing			Prior to Firing			After Firing			Prior to Firing		
	Prior to Firing	518 Rds.	Firing	Prior to Firing	518 Rds.	Firing	Prior to Firing	518 Rds.	Firing	Prior to Firing	518 Rds.	Firing
4.75	0.79C	0.8215	0.789	0.789	0.8215	0.789	0.8195	0.8255	0.8195	0.8255	0.8195	0.8255
5.00	0.789	0.820	0.7885	0.788	0.820	0.788	0.8195	0.827	0.8195	0.8275	0.8195	0.827
6.00	0.788	0.814	0.788	0.788	0.814	0.788	0.8195	0.825	0.8195	0.8225	0.8195	0.8225
7.00	0.788	0.814	0.788	0.788	0.814	0.788	0.8195	0.820	0.8195	0.820	0.8195	0.820
8.00	0.788	0.8115	0.788	0.7875	0.8115	0.7875	0.8195	0.8185	0.8195	0.8185	0.8195	0.8185
9.00	0.788	0.808	0.788	0.7875	0.808	0.7875	0.8195	0.8175	0.8195	0.8175	0.8195	0.8175
10.00	0.788	0.8045	0.788	0.7875	0.8045	0.7875	0.8195	0.8175	0.8195	0.8175	0.8195	0.8175
15.00	0.788	0.799	0.788	0.788	0.799	0.788	0.8195	0.8175	0.8195	0.8175	0.8195	0.8175
20.00	0.7875	0.790	0.7875	0.7875	0.790	0.7875	0.8195	0.8175	0.8195	0.8175	0.8195	0.8175
25.00	0.788	0.7875	0.7875	0.7875	0.7885	0.7875	0.8195	0.8175	0.8195	0.8175	0.8195	0.8175
30.00	0.788	0.7875	0.7875	0.7875	0.7875	0.7875	0.819	0.8175	0.819	0.8185	0.8195	0.818
35.00	0.788	0.7875	0.7875	0.7875	0.7880	0.7875	0.819	0.8175	0.819	0.8175	0.8195	0.818
40.00	0.7875	0.788	0.7875	0.7875	0.7885	0.7875	0.819	0.818	0.819	0.8175	0.819	0.818
45.00	0.7875	0.789	0.7875	0.7875	0.789	0.7875	0.819	0.818	0.819	0.8175	0.819	0.8175
46.00	0.7875	0.789	0.7875	0.7875	0.789	0.7875	0.819	0.817	0.819	0.817	0.819	0.817
47.00	0.7875	0.789	0.7875	0.7875	0.7885	0.7875	0.819	0.817	0.819	0.817	0.819	0.817
48.00	0.7875	0.789	0.7875	0.7875	0.7895	0.7875	0.819	0.817	0.819	0.817	0.819	0.817
49.00	0.7875	0.7895	0.7875	0.7875	0.790	0.7875	0.819	0.817	0.819	0.817	0.819	0.817
50.00	0.7875	0.790	0.7875	0.7875	0.790	0.7875	0.819	0.817	0.819	0.817	0.819	0.817
51.00	0.7875	0.790	0.7875	0.7875	0.791	0.7875	0.819	0.817	0.819	0.817	0.819	0.817
52.00	0.7875	0.7915	0.7875	0.7875	0.793	0.7875	0.819	0.818	0.819	0.818	0.819	0.818

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NPG REPORT NO. 1342  
NAVORD REPORT NO. 1339

TABLE 34 CHAMBER MEASUREMENT DATA

Barrel No. 856686, 20mm Mk 11 Mod 2

Distance from Breach Surface (ins.)	Drawing Dimensions	Chamber Diameter (ins.)	
		Prior to Firing	After Firing 518 Rds.
.359	1.1531+.002	1.1558	1.1558
1.209	1.1233+.002	1.1263	1.1263
1.739	1.1048+.002	1.1072	1.1072
2.239	1.0873+.002	1.0900	1.0901
2.739	1.0698+.002	1.0727	1.0727
3.039	1.0593+.002	1.0619	1.0619
Specs. 3.693+.005	.942	.9436	.9437
4.100	.834+.003	.8401	.8401
4.200	.834+.003	.8383	.8376
4.300	.834+.003	.8371	.8368
4.400	.834+.003	.8355	.8342
Specs. 4.458+.020	.828	.8316	.8324
Actual 4.4755		.828	.8307

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TABLE 35

TABULATED FIRING DATA

Date Fired: 12 May 1953  
 20mm Aircraft Gun Mk 12 Mod 0 Serial No. 500832  
 20mm Barrel Mk 11 Mod 2 Serial No. 855119 Unplated (56 Previous Rounds)  
 Ammunition: Production Lot ZS-7-HMC-53 - Standard 20mm Mk 11 Mod 0 Target Projectiles  
 - 661 grains IMR 6962 Lot DSZA-5 Propellant Powder

Burst	Time	Belted	Fired	Rds. on Barrel	Cyclic Rate (rpm)	Average Velocity (ft./sec.)	Yaw (Degrees)*						Remarks		
							0-5		6-10		11-15			16-20	
							No.	Rds.	No.	Rds.	No.	Rds.		No.	Rds.
1	1050	50	6	62	974	3305	6						Rounds in chamber, firing pin mark.		
2	1052	44	37	99	985	3361	36	1					Round in chamber, firing pin mark, hesitation in burst.		
3	1055	50	44	143	1024	3315	34	6	3	1			Round in chamber, firing pin mark.		

Note: Above 3 stoppages due to defective synchronizing switch, new synchronizing switch installed.

4	1058	50	50	193	1008	3282	35	9	5	1			
5	1100	50	7	200	1000	3237	5	2					Stubbed round.

Note: Feed mechanism EX-259 right hand removed and EX-214 right hand installed.

6	1102	42	42	242	995	3250	26	10	6				
7	1104	50	50	292	983	3222	37	9	3				

Note: Paper in yaw machine broke, therefore, yaw not measured on remaining bursts.

8	1106	50	50	342	975	3210							
9	1108	50	50	392	972	3175							
10	1111	50	50	442	968	3163							
11	1115	50	50	492	955	3142							

\* Rounds omitted could not be measured.

### BARREL MEASUREMENT DATA

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Distance from Muzzle Surface (ins.)	Bore (C <sup>8</sup> 787+Q <sup>1</sup> 002-Q <sup>1</sup> 000)						Grooves (O <sup>1</sup> 817+Q <sup>1</sup> 004-Q <sup>1</sup> 000)					
	After			Prior			After			Prior		
	Firing	Prior to 492 Rds.	After Firing 492 Rds.	Firing	Prior to 492 Rds.	After Firing 492 Rds.	Firing	Prior to 492 Rds.	After Firing 492 Rds.	Firing	Prior to 492 Rds.	After Firing 492 Rds.
4.75	0.7915	0.824	0.7915	0.824	0.7915	0.824	0.818	0.8255	0.818	0.8255	0.818	0.8255
5.00	0.790	0.8195	0.7905	0.824	0.790	0.825	0.818	0.824	0.818	0.8255	0.818	0.8255
6.00	0.7895	0.809	0.7895	0.824	0.789	0.824	0.818	0.819	0.818	0.819	0.818	0.819
7.00	0.789	0.805	0.789	0.824	0.789	0.824	0.818	0.8155	0.818	0.8155	0.818	0.816
8.00	0.789	0.801	0.789	0.803	0.789	0.803	0.818	0.816	0.818	0.816	0.818	0.815
9.00	0.7885	0.789	0.7885	0.798	0.789	0.798	0.818	0.816	0.818	0.816	0.818	0.816
10.00	0.7885	0.7965	0.7885	0.796	0.789	0.796	0.818	0.816	0.818	0.8165	0.818	0.8165
15.00	0.788	0.7915	0.788	0.792	0.788	0.7915	0.818	0.8165	0.818	0.8165	0.818	0.817
20.00	0.7875	0.788	0.7875	0.7875	0.7875	0.7885	0.818	0.8165	0.818	0.8165	0.818	0.8175
25.00	0.7875	0.787	0.787	0.787	0.787	0.787	0.818	0.8165	0.818	0.8165	0.818	0.8175
30.00	0.7875	0.7875	0.787	0.787	0.787	0.787	0.818	0.8165	0.818	0.817	0.818	0.817
35.00	0.787	0.7875	0.787	0.787	0.787	0.787	0.818	0.8165	0.818	0.8165	0.818	0.817
40.00	0.787	0.788	0.787	0.787	0.787	0.787	0.818	0.816	0.818	0.816	0.818	0.817
45.00	0.787	0.7875	0.787	0.787	0.787	0.7875	0.818	0.816	0.818	0.8165	0.818	0.817
46.00	0.787	0.7875	0.787	0.7875	0.787	0.787	0.818	0.816	0.818	0.8165	0.818	0.817
47.00	0.787	0.7875	0.787	0.787	0.787	0.787	0.818	0.816	0.818	0.8165	0.818	0.8165
48.00	0.787	0.7875	0.787	0.7875	0.787	0.787	0.818	0.8165	0.818	0.8165	0.818	0.8175
49.00	0.787	0.788	0.787	0.788	0.787	0.7875	0.818	0.8165	0.818	0.8165	0.818	0.8175
50.00	0.787	0.7875	0.787	0.7875	0.787	0.788	0.818	0.8165	0.818	0.8165	0.818	0.8175
51.00	0.787	0.788	0.787	0.7875	0.787	0.788	0.818	0.8165	0.818	0.817	0.818	0.817
52.00	0.787	0.789	0.787	0.788	0.787	0.788	0.818	0.8165	0.818	0.8165	0.818	0.817
52.25	0.7875	0.788	0.787	0.788	0.787	0.789	0.818	0.8165	0.818	0.8165	0.818	0.817
52.40	--	--	--	--	--	--	0.818	0.817	0.818	0.817	0.818	0.8175

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NPG REPORT NO. 1342  
NAVORD REPORT NO. 1339

TABLE 37 CHAMBER MEASUREMENT DATA

Barrel No. 855119, 20mm Mk 11 Mod 2

Distance from Breech Surface (ins.)	Chamber Diameter (ins.)	
	Prior to Firing	After Firing 492 Rds.
	Drawing Dimensions	
.359	1.1531+.002	1.1542
1.209	1.1233+.002	1.1245
1.739	1.1048+.002	1.1059
2.239	1.0873+.002	1.0891
2.739	1.0698+.002	1.0713
3.039	1.0593+.002	1.0609
Specs. 3.693+.005	.942	.9389
4.100	.834+.003	.8348
4.200	.834+.003	.8340
4.300	.834+.003	.8324
Specs. 4.458+.020	.828	.8303
4.464		.8298
4.512		.828

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APPENDIX H

DISTRIBUTION

## Bureau of Ordnance:

Ad3	1
Ad6	20
Re5	1
Re5e	1
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<p>MPG 1342</p> <p>Naval Proving Ground, Dahlgren, Virginia</p> <p>DEVELOPMENT AND TEST OF NYLON ROTATING BAND FOR 20MM HIGH VELOCITY PROJECTILE, by R. B. Butler. 10 March 1955. 13p. tables. append A-H. MPG Report No. 1342. NAVORD Report No. 1339. Task assignment MPG-B-3b-225-1-54) CONFIDENTIAL</p> <p>Previously reported work on the development of a nylon rotating band for the 20mm aircraft gun Mk 12 had shown that the band as developed imparted full spin to the projectile, obturated satisfactorily, and did not fringe noticeably or produce unacceptable yaw, in slow fire at muzzle velocities up to 3500 ft/sec and at temperatures from -65° to 160°F. On the basis of a relatively small amount of firing, the band appeared to be completely retained in flight even at the temperature extremes. This report continues the account of the development work on this band, including additional extreme temperature firing, firing for ballistic accuracy, and rapid-fire tests.</p>	<p>I. Rotating bands - Test results</p> <p>I. Butler, R. B.</p> <p>II. NAVORD 1339</p>
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